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L.M.B.C. MEMOIRS.

XIX.

POLYCHÆT LARVÆ.

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Liverpool Marine Biology Committee.

L.M.B.C. MEMOIRS

ON TYPICAL BRITISH MARINE PLANTS & ANIMALS

EDITED BY W. A. HERDMAN, D.Sc., F.R.S.

XIX.

POLYCHÆT LARVÆ

F. H. GRAVELY, M.Sc.
DEMONSTRATOR OF ZOOLOGY IN THE UNIVERSITY OF MANCHESTER

(With 4 Plates)

PRICE TWO SHILLINGS AND SIXPENCE

LONDON
WILLIAMS & NORGATE
AUGUST, 1909

EDITOR'S PREFACE.

THE Liverpool Marine Biology Committee was constituted in 1885, with the object of investigating the Fauna and Flora of the Irish Sea.

The dredging, trawling, and other collecting expeditions organised by the Committee have been carried on intermittently since that time, and a considerable amount of material, both published and unpublished, has been accumulated. Twenty-two Annual Reports of the Committee and five volumes dealing with the "Fauna and Flora" have been issued. At an early stage of the investigations it became evident that a Biological Station or Laboratory on the sea-shore nearer the usual collecting grounds than Liverpool would be a material assistance in the work. Consequently the Committee, in 1887, established the Puffin Island Biological Station on the North Coast of Anglesey, and later on, in 1892, moved to the more commodious and accessible Station at Port Erin in the centre of the rich collecting grounds of the south end of the Isle of Man. A larger Biological Station and Fish Hatchery, on a more convenient site at Port Erin, has since been erected, and was opened for work in July, 1902.

In these twenty-two years' experience of a Biological Station (five years at Puffin Island and seventeen at Port Erin), where College students and young amateurs form a large proportion of the workers, the want has been frequently felt of a series of detailed descriptions of the structure of certain common typical animals and plants, chosen as representatives of their groups, and dealt with by specialists. The same want has probably been felt in other similar institutions and in many College laboratories.

The objects of the Committee and of the workers at the Biological Station were at first chiefly faunistic and speciographic. The work must necessarily be so when opening up a new district. Some of the workers have published papers on morphological points, or on embryology and observations on life-histories and habits; but the majority of the papers in the volumes on the "Fauna and Flora of Liverpool Bay" have been, as was intended from the first, occupied with the names and characteristics and distribution of the many different kinds of marine plants and animals in our district. And this faunistic work will still go on. It is far from finished, and the Committee hope in the future to add still further to the records of the Fauna and Flora. But the papers in the present series, started in 1899, are quite distinct from these previous publications in name, in treatment, and in purpose. They are called "L.M.B.C. Memoirs," each treats of one type, and they are issued separately as they are ready, and will be obtainable Memoir by Memoir as they appear, or later bound up in convenient volumes. It is hoped that such a series of special studies, written by those who are thoroughly familiar with the forms of which they treat, will be found of value by students of Biology in laboratories and in Marine Stations, and will be welcomed by many others working privately at Marine Natural History.

The forms selected are, as far as possible, common L.M.B.C. (Irish Sea) animals and plants of which no adequate account already exists in the text-books. Probably most of the specialists who have taken part in the L.M.B.C. work in the past will prepare accounts of one or more representatives of their groups. The following list shows those who have either performed or promised.

Memoirs from I. to XIX. have now been published.

The present memoir, on Polychaet Larvae, by Mr. F. H. Gravely, differs from its predecessors inasmuch as it deals not with a single adult organism, but with a group of associated larval stages. It is believed that this new departure will prove useful to students of plankton at Biological Stations. Doris, by Sir C. Eliot, is far advanced and ought to be out during 1909. It is hoped that Zostera, Cucumaria, Buccinum, and the Oyster will follow soon.

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BUCCINUM, W. B. Randles.

BUGULA, Laura R. Thornely.
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ZOSTERA, R. J. Harvey Gibson.
HIMANTHALIA, F. J. Lewis.
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FUCUS, J. B. Farmer.
BOTRYLLOIDES, W. A. Herdman.
ACTINIA, J. A. Clubb.
HYDROID, E. T. Browne.
HALICHONDRIA and SYCON, A. Dendy.
SABELLARIA, A. T. Watson.

In addition to these, other Memoirs will be arranged for, on suitable types, such as *Pagurus*, *Pontobdella*, a Cestode and a Pycnogonid.

As announced in the preface to ASCIDIA, a donation from the late Mr. F. H. Gossage, of Woolton, met the expense of preparing the plates in illustration of the first few Memoirs, and so enabled the Committee to commence the publication of the series sooner than would otherwise have been possible. Other donations received since from Mrs. Holt, Sir John Brunner, and others, are regarded by the Committee as a welcome encouragement, and have been a great help in carrying on the work.

W. A. HERDMAN.

University of Liverpool,
August, 1909.

L.M.B.C. MEMOIRS.

No. XIX.

POLYCHAET LARVAE OF PORT ERIN.

BY
F. H. GRAVELY, M.Sc.,
Junior Demonstrator of Zoology in the Victoria University of Manchester.

INTRODUCTION.

PREVIOUS WORK UPON POLYCHAET LARVAE OF THE L.M.B.C. DISTRICT.

There appear to be only two papers which touch upon this subject. Mr. Chadwick (1899) has recorded the tubicolous post-larval stage of *Pectinaria* and also the larvae of several other Polychaets; some of the latter are figured, but none identified. Mr. Hornell's account of the L.M.B.C. Polychaeta (1891) includes a "Note on the Embryology of *Arenicola* and *Scoloplos*." It would appear, however, from the foot-note to p. 314 of Vol. II. of the Cambridge Natural History that the egg-capsules and larvae here referred to as those of *Arenicola* are now known to belong to a Phyllodocid—*Phyllodoce maculata* according to Hornell himself; *Eulalia viridis* according to some others. Hornell's figures of these larvae strongly suggest that the tuft of apical cilia that he describes represents in reality the "hook" of cilia characteristic of Phyllodocid larvae; and they closely resemble McIntosh's figures of the larvae of *Phyllodoce maculata* (McIntosh: 1869).

MATERIAL AND METHODS.

The larvae which form the subject of the present paper may all be obtained at Port Erin during July; but the observations recorded were commenced in 1907 about the middle of June, and in 1908 were continued during the early part of August.

All the species have been obtained in the bay, for the most part just inside the breakwater or further out towards the cliffs opposite the Biological Station. Townettings were also taken one evening between Aldrick Bay and the Calf Island, but the catch contained just the same Polychaet larvae as those from within the bay.

A simple bolting-silk tow-net (mesh 94), usually sunk some distance (probably about 3 fathoms) below the surface, was used to obtain the plankton which was either fixed in the boat or taken up to the laboratory and examined immediately in the living condition; none of the larvae were reared in the aquarium. Notes and rough sketches of the living larvae were made in the laboratory, and from these and stained microscopical preparations the following descriptions and figures have been drawn. In some instances use has also been made of sections to determine doubtful points.

Whilst examining the living larvae I endeavoured to obtain measurements of their cilia. This was rendered extremely difficult both by their great activity and their frequently oblique position or curvature. The measurements given must therefore be regarded as approximate only. In the case of cilia projecting obliquely from the body, I have endeavoured to ascertain the length of the cilia and not the perpendicular distance of their distal ends from the body, a measurement that may easily be taken to represent their actual length as long as they are actively in motion. Though only approximate, these figures will, I think, convey a better idea of the relative lengths of various cilia than could be obtained from the constant use of such vague comparative terms as "long," "medium," and "short."

This paper can only claim to give a preliminary account of the larvae it describes; as, however, many of these larvae have not been described before, and as no systematic account of British Polychaet larvae has yet been attempted, even for such a limited area and part of the year as Port Erin Bay during the month of July, it seems advisable to publish it in its present form, and to leave the obvious gaps in some of the accounts to be filled in as opportunity presents itself. I have endeavoured by references to previous work on the subject to indicate briefly the nature and extent of the variability of larvae within each of the families dealt with, and their complete life-histories as far as they are at present known.

I should like to express my thanks to Prof. Hickson for nominating me to the Manchester University table in the laboratory at Port Erin during the times I was collecting the material described below; also to Prof. Herdman for very kindly supplying me with samples of the plankton he collected from his steam-yacht "Ladybird" in the large "shear-net," from which it was hoped —unfortunately in vain—that there might be obtained later stages of Polychaet larvae than those caught in the ordinary small tow-nets; and finally to Mr. Chadwick for many valuable suggestions, and ready help in many ways.

DESCRIPTIONS OF THE LARVAE.

I.—NEREIDIFORMIA.

SYLLIDÆ.

Three species of undoubted Syllid larvae have been found. As these closely resemble each other in general features, they may be treated together and distinguished when necessary as Syllids *A*, *B*, and *C* respectively. It is impossible to determine even the genus of any one of them.

Metatrochophore.*—Two specimens (one of sp. *A*, the other of sp. *C*) are in the second metatrochophore stage, but I have not had the opportunity of examining them alive. No earlier stage than this has been seen. These two larvae are pear-shaped (about 350μ long by 250μ maximum diameter), with the prototroch (or "preoral" ciliated band) in the position of greatest breadth. There is a narrow ciliated tract round the mouth; and the akrotroch and one pair at least of the eyespots seen in living specimens of the Nectochaeta of species *A* are probably also present, in that species at any rate.†

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* The technical terms commonly adopted in describing the different stages, larval organs, etc., found during the development of Annelids are those defined by Häcker (1897, pp. 74-76). Most of these terms require no alteration to render them suitable for English use: the term "Zwischenparatroch" has, however, been replaced by "Interparatroch," and the term "Endparatroch" by the less awkward and equally well known term "Telotroch." In addition to the terms defined by Häcker I have found it convenient to distinguish, with Claparède (1863, p. 87), between amphitrochal, nototrochal and gastrotrochal segmental ciliated bands according to whether they completely encircle the body or are confined to the dorsal or to the ventral surface. In addition I have used the term "Neurotroch" to designate the longitudinal ciliated tract frequently found between the mouth and anus. Definitions of all these terms will be found in my "Studies on Polychaet Larvae" (Gravely, 1909, pp. 597-600).

† See footnote to Nectochaeta stage below.

Only the five primary segments are present, but of these the last three bear appendages, even in the younger specimen (sp. *C*); whilst in the other (sp. *A* : Pl. I., fig. 1) the first (peristomial) segment bears on each side a lobe representing its dorsal cirrus; the second bears two similar lobes, representing respectively the single ramus of the parapodium, and its dorsal cirrus; the third bears a similar rudimentary dorsal cirrus, but a distinct chaetigerous parapodial ramus; the fourth a still longer parapodium; and the fifth a parapodium somewhat shorter than that of the fourth segment.

Nectochaeta.—This stage may be said to begin in the Syllidae with the development of the parapodia of the anterior secondary segments. During this development the ventral peristomial cirri appear, together with the ventral cirri of the anterior chaetigerous segments, the cephalic tentacles, and palps; whilst the dorsal peristomial cirri increase in length.

The prototroch, in species *A* at least, is still used for swimming, whilst the parapodia are used for crawling whenever swimming is impeded. The setae are very long, and can be almost entirely withdrawn into the parapodium. The prototroch is complete, and consists of two rows of cilia* (Pl. I., fig. 1); those of the anterior row are 70μ in length, those of the posterior 50μ. The mouth is lined with shorter cilia, and an akrotroch—a tuft or row of cilia between the prototroch and the apical plate—is present in the form of a median ventral tuft of cilia 20μ in length, situated just in front of the prototroch in the hollow between the umbrella and the apical region of the

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I have since been able to distinguish in a Syllid Metatrochophore (? Syllid B*) a row of very short cilia anterior to these, as in *Polynoë*. These two rows, therefore, correspond to the posterior two rows of equal cilia in *Polynoë*, which they further resemble in that one row is held directed forwards and the other backwards. This larva bore three pairs of eyespots and a tuft of akrotrochal cilia 20μ long.

larva. No cilia have been detected upon any other segment.

The larva is transparent and almost colourless except for material in the gut, two pairs of opaque, dark brown or black eyespots on the dorsal surface of the prostomium, and traces of opaque pigment on the prostomium and on the posterior surface of the anal segment.

Syllid A (Pl. I., figs. 1 and 2).—This, the most plentiful, is characterised by the setae shown in fig. 2; one of the simple (anterior) and four or five of the compound setae occur in each tuft. Anal styles are present in every specimen, being indicated even in the Metatrochophore shown in Pl. I., fig. 1.

In the oldest specimen obtained there are seven chaetigerous segments, the parapodia of the first of these still being shorter than those of the segment immediately behind them; both dorsal and ventral cirri are present on every parapodium, the dorsal at its base, the ventral about half way along it; the dorsal cirrus is larger than the ventral. The two pairs of peristomial cirri are both present, the dorsal being about 100μ long, and the ventral rather less than half that length; the dorsal pair are very slender, and transparent distally. There is no trace of cephalic tentacles or palps. In one Nectochaeta of this species a stout aciculum, slightly curved distally, is embedded in the tissues at the base of the peristomial cirri.

Syllid B (Pl. I., fig. 3).—This species is characterised by the presence, in each tuft of setae, of two simple capillary setae, one shorter and more slender than the other, and several compound ones, the latter each with a long filamentous distal segment (Pl. I., fig. 3).

The two youngest larvae seen both possess five pairs of parapodia, and are 500μ in length by 150μ in breadth. Though possessing fewer segments than the oldest specimen of *Syllid A* described above, the tentacles and dorsal cirri are much more fully developed; all three cephalic tentacles are present, though very short—the median one especially so. A pair of broad, but slightly developed, lobes, situated at the sides of the head immediately in front of the prototroch, represent the developing palps.

The dorsal peristomial cirri are longer than the ventral, but shorter than the dorsal cirri of the second (first chaetigerous) segment, which likewise exceed in length those of the succeeding segments. As in *Syllid A*, however, the rami of the parapodia of the second segment are shorter than those of the third. The parapodia of the fourth and succeeding segments only, each bear, close to their distal extremities, a short ventral cirrus. Anal styles are not present, but may have been shed at death.

The only other larva of this species that has been seen is much longer in proportion to its breadth, on account of the presence of two additional segments which have developed unaccompanied by any increase in breadth. The parapodia, with their dorsal cirri, are shorter than in the younger specimens, probably through contraction; their lengths relative to each other, however, remain the same, with the parapodia of the first chaetigerous segment shorter than those of the second. The ventral cirri are slightly more developed than in the younger larvae, and are still absent from the first two pairs of chaetigerous appendages. Anal styles are present and of considerable size.

Syllid C (Pl. I., fig. 4). Only a single specimen has been found, and that in an earlier stage than any of the other Syllid larvae. It is characterised by the rounded end of the proximal segment of its compound setae (Pl. I., fig. 4, B), this being pointed in the other two species; by the form of the distal segment of these setae (Pl. I., fig. 4, B); and by the form of the simple setae (Pl. I., fig. 4, A), which occur one in each bunch.

Three pairs of parapodia only are present, the first two segments being as yet in no way recognisable externally. These three pairs of parapodia (belonging to segments 3-5) scarcely project at all as lobes from the sides of the body, but each bears a tuft of well-developed setae.

Malaquin (1893, pp. 389-426) has fully described and figured the development of *Autolytus edwardsi* and *Eusyllis monilicornis*; and in less detail, that of *Syllis hyalina*, *Grubea*, *Exogone*, and a few other forms. His larvae are all of the same general type as the three described above, but differ from them in important specific characters. He finds that those larvae in which the early developmental stages are most slowly passed through are polytrochal, the cilia appearing very early and, excepting those of the prototroch, being confined to the dorsal surface and disappearing from before backwards. In those forms, however, in which the early stages are abbreviated the cilia do not appear until a later period, and then only on the head and posterior segments. Finally, in extreme cases, the cilia are not developed at all. Some larvae of this last type—*Exogone gemmifera*, *Sphaerosyllis pirifer*, *Syllides pulliger* (?), and *Grubea limbata* (?)—are carefully described by Viguier (1884); these larvae also conform to the same general type as the other Syllid larvae. Of this same form also are the four species of atrochal larvae belonging to the tribe Exogoneae and the polytrochal Odontosyllis larva described and figured by De Saint-Joseph (1886: Pl. X., figs. 76, 78-80, 86-91; and Pl. VIII., fig. 40). A slightly different form of larva has, however, been described by Korschelt (1893: pp. 279-285, Pl. XIII., figs. 16-29) under the name of "*Harpochaeta cingulata*" and referred to the Syllidae. This larva is polytrochal, its appendages arise much later than appears to be usual in the Syllidae, and it is characterised in the later stages by the presence of a pair of stout sickle-shaped bristles on every segment after the fourth, and by the deeply pigmented anal segment.

(?) Syllid (Pl. I., fig. 5).—Only the first metatrochophore stage of this larva has been seen, and this gives no clue to its systematic position; it appears, however, to be of the same species as a larva described by Häcker (1896: pp. 82-84; Pl. III., figs. 6-7) and considered by him to be probably a Syllid. Only two specimens have been seen, and these were not examined alive. The larva is nearly four times as long as it is broad, and bears four equally developed ciliated bands, one near each end and the other two a quarter and half way respectively from the anterior to the posterior band (Pl. I., fig. 5). The maximum breadth of the larva occurs between the second and third bands, there being no umbrella. Häcker figures a pair of eyespots in front of the anterior ciliated band in his larva. No setae are present.

Häcker (1896, pp. 82-84: Pl. III., figs. 6-7) describes and figures this and a later metatrochophore stage of this or a very similar larva. The latter has about fifteen segments, each containing a stout sickle-shaped bristle, but bearing no projecting parapodia. The eyes (still a single pair) are larger than before, and there is an extremely large and conspicuous patch of pigment on the anal segment. He considers that this larva comes very near to "*Harpochaeta cingulata*," described by Korschelt

(1893: p. 279; Pl. XIII., figs. 16-29), on account of its general form, its polytrochy, the position of its eyespots, the condition of its mid-gut, its sickle-shaped bristles, and the pigmentation of its anal segment. Of these characters the polytrochal condition of this larva appears to me to be a secondary specialisation, quite distinct from the simple polytrochal condition of "*Harpochaeta*"; nor do any of the characters seem very conclusive. Our form is certainly very unlike any other known Syllid larva, such as De Saint-Joseph's, as Häcker himself points out; and although "*Harpochaeta*" may to some slight extent help to bridge the gap, the evidence that this larva is a Syllid appears to me to be insufficient.

POLYNOIDÆ. (Pl. I., figs. 15-20.)

There appear to be several species, belonging to one or more genera of the Polynoidae, occurring as larvae at Port Erin during July. I have not yet been able to go fully into the differences between them, but the following account refers especially to the commonest of these, and with but slight modifications is true of all.

Trochophore.—The Trochophore after fixation is usually somewhat longer than it is broad, having a length of 300μ and a breadth of 250μ; but during life it is of a more nearly spherical shape (Pl. I., fig. 15). The commonest form appears to be of a deep violet colour, on account of the pigmentation of the walls of the stomach.

The prototroch consists of three rows of cilia (Pl. I., fig. 15, 15a), which are probably carried by three corresponding rows of cells. The cilia of the most anterior row are 15μ long, and sections show that this row is situated slightly in front of the other two, which arise close together, the cilia of one being directed forwards and those of the other backwards; the cilia of both these rows are 80μ long.

The apical pole of the larva bears a circlet of 40μ cilia, and close to this is situated dorsally a slight thickening of the body-wall (Pl. I., fig. 15, *T. med.*), the rudiment of the median cephalic tentacle. Between the apical cilia and the prototroch an akrotroch (Pl. I., figs. 15, 15a, *Akr.*) extends about half way across the ventral surface; of these cilia those near the middle line are longer (40μ) than the rest (20μ).

A little in front of and dorsal to the ends of the akrotroch is situated a somewhat crescentic eyespot of an extremely dark brown colour. The mouth opens below a very prominent upper-lip, along which the prototroch extends (Pl. I., figs. 15, 15a). On each side of the mouth there extend downwards and forwards from the posterior border of the prototroch a row of exceptionally long (150μ) cilia, which are always held straight and motionless, with their distal ends converging (Pl. I., fig. 15, *C*); these cilia appear to be absent in some species. Behind the prototroch a patch of 30μ cilia extends backwards round the mouth over quite an extensive portion of the ventral surface (Pl. I., fig. 15a, *C. or.*). A neurotroch (cilia 4μ long) extends forwards from the anus, but does not quite reach this oral ciliated area.

The deeply-staining region of the prostomium (rudiment of the supra-oesophageal ganglion—see Häcker, 1895, pp. 258-9) is large (Pl. I., fig. 15, *Ant.*). Another pair of deeply-staining masses of tissue, meeting in the middle line, extend on the ventral surface from the prototroch to the posterior end of the body, and mark the region of the subsequent development of parapodia and ventral nerve cord. The dorsal portion of the body-wall is thin and transparent.

The oesophagus is very narrow, and already bears a pair of little diverticula which ultimately form the thick walls of the pharynx. The stomach—which often contains the skeletal parts of unicellular organisms—is provided with a large dorsal lobe or caecum (Pl. I., fig. 15, *Caec.*), and its walls are thickly packed with minute opaque granules which probably give them their deep violet colour.

Metatrochophore.—The first metatrochophore stage closely resembles the trochophore, but is distinguished by the segmentation of the deeply-staining tissues of the ventral surface behind the prototroch. The larva is, moreover, larger and two pairs of more rounded eyes appear, one slightly anterior and the other slightly dorsal to the original crescentic pair. A very short row of 150μ cilia can often be detected along the dorsal side of each of the crescentic eyes in this and later stages; I have been unable to find these in the specimens of the trochophore stage.

The Metatrochophore increases in size and becomes more pointed at the posterior end (Pl. I., fig. 16) as it passes into its second phase. The peristomial cirri appear close together immediately behind the prototroch; a pair of anal styles appear at the posterior end; and between these, set very close together, the parapodia of seven chaetigerous segments develop. Each of these shows from the very first recognisable rudiments of all parts of the fully formed appendage except the dorsal tuft of setae; whilst the elytra of segments 2, 4, 5, 7 (and later 9, 11, 13, etc.) are more disc-like than the dorsal cirri of the other segments even at this early stage (Pl. I., fig. 16, *El.*). The pair of diverticula of the oesophagus have become much larger, and their walls much thicker than in the Trochophore.

By the end of the metatrochophore stage (Pl. I., fig. 17) the appendages of the first eight segments have all assumed their final form. The parapodia project from the body-wall to a distance of 100μ (exclusive of the setae), and the dorsal tuft of setae has made its appearance; the elytra are about 150μ in diameter. The parapodia of the ninth segment are developing: it is hard to determine whether this is a belated primary or precocious secondary segment, for although it appears only after the parapodia of the eight preceding segments have reached an advanced stage, yet it develops so rapidly that it soon reaches the same condition, and the parapodia of these nine segments alone function throughout the nectochaeta stage, towards the end only of which do any further segments begin to appear.

Shortly before the end of the metatrochophore stage the neurotroch disappears. In preparation for the nectochaeta stage each segment is slightly elongated, so that the parapodia are less closely crowded and can function as organs of progression.

Nectochaeta.—The head has begun to lose its larval features: its breadth is considerably less than before; the prototroch gradually disappears; the akrotroch is reduced in extent and becomes extremely difficult to distinguish—it probably consists of a single pair of minute tufts of cilia situated on the ventral surface near the middle line, in the angle formed between the umbrella and the anterior part of the head. By the end of this stage these remnants of the akrotroch, the prototroch, the ciliated area round the mouth, and the cilia by the crescentic eyespot, have completely disappeared. The three cephalic tentacles and the palps can now be distinctly seen projecting from the surface of the head—the lateral tentacles dorsally over the anterior, the palps ventrally over the posterior ends of the lateral lobes of the brain, and the median tentacle slightly in front of the lateral ones.

The thick-walled pouches of the oesophagus coalesce to form the muscular pharynx in which the rudiments of the jaws may be recognised as chitinous projections (Pl. I., fig. 18). The parapodia of the ninth segment have now attained the full development of their parts. On the peristomial segment one or two slightly curved and extremely stout serrate setae project between the dorsal and ventral tentacular cirri, whilst the remaining segments bear parapodia with both dorsal and ventral tufts of longer serrate setae (Pl. I., fig. 20), of which the ventral are longer and more slender than the dorsal.

A short line of 20μ cilia often occurs at this stage on the proximal part of either the dorsal or ventral surface of the ramus of each parapodium, and sometimes on both surfaces; similar cilia occur just in front of the bases of the peristomial cirri. Häcker (1896: p. 111, foot-note 2) notes the presence of intertrochal cilia on the dorsal rami of the parapodia of his Naples Polynoë larva. Rudiments of the tenth segment appear, but its parapodia remain very small and bear no setae during this stage, in which there is indeed very little development in the body region; and Häcker has already pointed out that it is a period of comparative quiescence. A median caudal appendage, 20μ long by 4μ broad, is now present.

Further development.—The nectochaeta stage of *Polynoë* is regarded as terminating soon after the disappearance of the ciliated band, when the size of the head is still further reduced and the tentacles and palps lengthen till their final proportions are reached; the body-segments elongate again and additional ones rapidly develop, so that, so far as general proportions are concerned, the worm becomes a small but perfectly normal Polynoïd before abandoning the pelagic habit. The cilia on the parapodia are often found in the very latest pelagic stages.

Häcker described the development of a species of *Polynoë* in 1894, and published a more complete and fully illustrated paper on the same subject in the following year (1895). He described the internal anatomy as well as the external characters of these larvae, and in general his account applies to the Port Erin species also. In his larvae, however, there were only seven primary segments, and no segment developed between the first appearance of these and the end of the nectochaeta stage. The same author described and figured the same (?) species of Polynoë larva from Naples (1897: pp. 77-8, Pl. III., figs. 1-2), and a species with nine primary segments from the Atlantic coast collections of the German Plankton Expedition (1898: pp. 8-9, Pl. I., fig. 1).

De Saint-Joseph (1895: pp. 196-198; Pl. XI., figs. 15-17; Pl. XII , figs. 25-26) also describes the metatrochophore and nectochaeta stages of a Polynoë with seven primary segments. The larvae of *Lepidonotus squamatus* described by Fewkes (1885: pp. 185-186; Pl. III., figs. 1-4; Pl. IV., figs. 14-17) have only four primary segments. The development of *Lepidonotus squamatus*—a species recorded from the L.M.B.C. area—has been described by Leschke (1903: pp. 129-130; Pl. VI., fig. 14; Pl. VII., figs. 1-2). The Trochophore is stated to have a violet pigment in the stomach walls, and a single pair of eyes of crescentic shape, two other pairs appearing later just as in the commonest Port Erin larva. Further development, however, shows the appearance of only seven primary segments; and in the specimen shown in fig. 1 of his Pl. VII, one of the three pairs of eyespots is situated behind the prototroch. In the late stage seen in fig. 2 of the same plate—a stage remarkably like the post-nectochaeta stage of the Port Erin larvae—small tufts of cilia are described as occurring at the bases of the paired cephalic tentacles and palps.

McIntosh (1900: pp. 321-325; Pl. XXVIA, figs. 3-8, 10, and 12) describes and figures the pale greenish larvae of *Harmothoë imbricata*. He also (1900: p. 413) describes a larva, referred to a species either of *Sthenelais* or *Sigalion*, with bluish anterior digestive organs in the metatrochophore stage; whilst the larvae of *Phloe minuta* (described on p. 441) and of several unidentified species of Polynoidae (one described on pp. 325-6) are figured in the same work on Pl. XXVIA. Claparède has also described and figured Polynoë larvae (1863: pp. 80-81; Pl. VIII., figs. 7-11).

PHYLLODOCIDÆ.

Three kinds of larvae belonging to this family have been obtained. They all exhibit the same characteristic general appearance, but may be distinguished from each other by differences in the setae, and species *A* is of much smaller size than either of the other two.

Phyllodocid A.—*Mystides*—(Pl. II., figs. 6-7.)

Trochophore.—This larva is very much commoner (during July) than either of the larger species. The Trochophore is of a pale brown colour and is extraordinarily contractile. When fully extended, the region in front of the prototroch is slightly longer than the region behind it, and the outline is roughly elliptical (Pl. II., fig. 6); when fully contracted the larva becomes broader than it is long, the transverse axis changing from 80 to 100μ, and the longitudinal axis from 160 to 80μ.*

The prototroch is probably double, with an anterior row of short, and a posterior row of long cilia, though as this was not investigated until after the trochophore stage had disappeared from the plankton, I can only describe it as such with certainty at a later stage; the long cilia are 100μ in length. In the largest Trochophores an eyespot of red pigment is present on each side of the prostomium, slightly on the dorsal surface, but I have been unable to find any cilia such as those described by Häcker 1896: pp. 84 and 85; Pl. III., figs. 8-9) just behind the eyes of his Phyllodocid larvae. Almost on a level with the eyes there is situated on the ventral surface, but apparently not always in the middle line, the "hook" of cilia stated by Häcker (1896: p. 84) to be characteristic of Phyllodocid larvae. These cilia (Pl. II., fig. 6; *Med. Hk.*) are 25μ long, but amongst them are a number of shorter cilia (15μ long) forming the posterior end of the median piece of a **T**-shaped akrotroch (Pl. II., fig. 6; *Akr*). The paired "hooks" of cilia present in species *C* have not been seen in larvae of the present species, in which, however, the details of the akrotroch are extremely difficult to make out. A scanty tuft of short straight cilia 7μ in length is situated at the apex of the prostomium.

The mouth is situated unusually far behind the proto-

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*There is some reason to believe that "*Phyllodocid A*" as described here really includes two species. The first Trochophores found were slightly larger and more deeply pigmented than those from which these measurements were taken and which were first noticed on the following day. At the time I attributed this to the latter having appeared in the bay in a younger stage than any previously examined; but as there appear to be also two slightly dissimilar types amongst the older larvae, I am now inclined to attribute these differences to a difference of species. The smaller type of Trochophore lacked the pair of eyespots that was present in the larger.

troch, and is lined with cilia; these cilia are all curved inwards towards the oesophagus, and are not continuous with the longer cilia of the prototroch; they are, however, continuous with a neurotroch, the cilia of which are only 10μ long. This neurotroch is in the form of a narrow median band, as in many other larvae, for the anterior third of its extent, but broadens out further back into a somewhat diamond-shaped tract, as shown in Pl. II., fig. 6 (*Ntr.*). The posterior angle of this tract is extended to the anus, which is closely surrounded by short cilia similar to those of the neurotroch. The true telotroch—though frequently, if not always, present—is also of very short cilia; it does not completely encircle the body, there being a ventral break in its continuity, the neurotroch extending through this without coming into contact with the telotroch.

The preoral (ganglionic) and postoral (subsequently segmented) deeply-staining cell-masses are much less conspicuous in these Trochophores than in those of *Polynoë*, and are very much smaller in the earlier than in the later phases of this stage.

Metatrochophore.—The first metatrochophore stage closely resembles the trochophore, but becomes somewhat larger, and the postoral deeply-staining cell masses are divided transversely into segments, of which the anterior are differentiated a little before the posterior. Although the segments thus appear in succession, it is possible to distinguish the seven that appear during the metatrochophore stage as primary segments, for their appendages reach an advanced state of development before any others are added. Very shortly after the appearance of segmentation, the appendages of these seven primary segments develop, and with this the second metatrochophore stage commences.

The peristomial segment bears a single pair of tentacular cirri; the second segment bears two pairs and a tuft of setae; and the remaining five segments bear uniramous chaetigerous parapodia, the first pair of these with a minute ventral, but no dorsal cirrus, and the rest with both a small dorsal and a small ventral cirrus. A pair of almost spherical anal styles develop at about the same time as these parapodia, and also the two pairs of cephalic tentacles, which appear close to the anterior end of the prostomium (as seen in Pl. II., fig. 7, of the nectochaeta stage) as extremely transparent conical outgrowths, about 40μ long.

The akrotroch with its unpaired "hook" is still present, its lateral extensions reaching very nearly to the cephalic tentacles. Two pairs of eyes are now present, one pair being smaller and slightly behind and on the inner side of the other, and embedded somewhat deeply in the tissues. The neurotroch and telotroch disappear before the end of the metatrochophore stage; but inter-paratrochal cilia appear—first on the ventral surface in tufts (10μ long), one below the base of each parapodium, and finally as complete amphitrochs (cilia 50μ long). The prototroch is still at the height of its development, and consists of an anterior row of short and a posterior row of long cilia. At the end of the metatrochophore stage the larva is 500μ long by 250μ broad; behind the seven primary segments an unsegmented region occupies about one-tenth of the entire length of the larva.

Nectochaeta.—The chief external changes that appear to take place during the remainder of the pelagic life of the larva are the development of additional segments from the anterior end of the anal unsegmented region, and the disappearance—shortly after this process has begun—of the akrotroch and oral cilia. Internally the pharynx becomes first clearly recognisable at this time; it is formed from a pair of pocket-like outgrowths of the oesophagus, as in Polynoë, but these only appear as thickenings of the wall of the oesophagus in whole mounts, and can rarely be seen at all until after the trochophore stage. The oldest larva obtained is in the fixed and slightly contracted condition 800μ long by 150μ average breadth; twelve intertrochal segments are present—their appendages bear slightly larger cirri than did those described in the previous stage. The dorsal cirri are more conical than foliaceous, but are stouter than the ventral. The setae are all jointed, and of the type shown in Pl. II., fig. *7a*; they are extremely transparent in balsam, and their exact shape is therefore very difficult to determine. The prototroch is still present, but the akrotroch and oral cilia, and probably also the interparatrochs, have disappeared. Only a single pair of eyes is present in this specimen; these are situated upon the dorsal surface of the head, and are dark brown and very opaque; by very strong transmitted light they are seen to be of a somewhat purplish brown colour. The pharynx is clearly marked, and joins the intestine between the fifth and sixth segments.

The four pairs of tentacles and three pairs of tentacular cirri show that this species belongs to the genus *Mystides*, Théel; whilst the arrangement of the tentacular cirri on the first two segments only is characteristic of the sub-genus *Mesomystides*, Cziernavsky. It is thus separated from *Mystides lizziae* (the only species of *Mystides* recorded by McIntosh in his Monograph of British Annelids) which belongs to the sub-genus *Promystides*, with one pair of tentacular cirri on each of the first three segments.

Phyllodocid B. —? *Eulalia*—(Pl. II., figs. 8-9.)

I have only been able to examine one specimen—a Nectochaeta—of this larva alive. In order to avoid confusion, all three stages will be first described from preserved specimens only, and the additional features seen in the one living specimen added at the end.

The two oldest (mounted) specimens show the characteristic appendages of a Phyllodocid, and another (a Metatrochophore) is undoubtedly a younger form of the same species as these, although no specially Phyllodocid features are visible. The remaining (mounted) specimen is a Trochophore, which shows a clear yellow pigmentation of the periphery, especially at the apical pole. The youngest of the three older larvae shows this clear yellow pigmentation in places, though not so extensively; the two Nectochaetae, like all other larval Polychaets obtained (excepting some of the Trochophores of the smaller species, "*Phyllodocid A*"), show no trace of it whatever: as, in addition, there is a general similarity of structure between the Metatrochophore and this Trochophore, and as the large size of the latter closely approximates to what would be expected of the trochophore stage of the former, it seems reasonable to refer them, provisionally at least, to the same species.

[Trochophore.—The Trochophore thus referred to is roughly spherical in shape, but its apical pole is somewhat flattened. Its greatest diameter is 350μ. The prototroch is strongly developed, and situated slightly above the equatorial plane. The mouth is surrounded by much shorter cilia. Paired anterior (ganglionic) and posterior (subsequently segmented) masses of deeply-staining tissue are present, and somewhat more conspicuous than in the Trochophores of *Phyllodocid A*; probably each of the ganglionic masses already bears an eye, but these cannot be at all clearly distinguished in the mounted specimen. Lateral (pocket-like ?) thickenings of the oesophageal walls (rudiments of the thick-walled pharynx) are already present. The walls of the stomach are quite free from opaque granules, no food being, however, discernible in any part of the gut.]

Metatrochophore II.—The only Metatrochophore seen already bears rudimentary parapodia (Pl. II., fig. 8). It is 650μ in length, and has a maximum diameter of 450μ, which now coincides with the position of the yellowish prototroch; the periphery in front of, and to a less extent also behind, this band shows a yellowish coloration, but not nearly so conspicuously as in the Trochophore. The preoral lobe bears a pair of conspicuous eyes on its dorsal surface. The mouth is still surrounded by cilia (Pl. II., fig. 8, *C. or.*); but the thickenings of the walls of the oesophagus have fused together in the middle line in front of the mouth.

Four pairs of tentacular cirri are present (one pair peristomial, two belonging to the second segment, and the fourth borne dorsal to the ramus of the first chaetigerous segment); they are all of about the same length (350μ). About ten further segments and a posterior unsegmented region are recognisable, each of the first six of these segments being provided with a short slender seta—either a simple capillary or the distal end only of a partially exposed jointed seta. Broad lobes, one above each chaetigerous lobe, represent the ultimately foliaceous dorsal cirri; anal styles are represented by short lobes originating behind a narrow telotroch.

Nectochaeta.—The last stage of this larva (that was seen) shows an increase in length to about

1,000μ, partly owing to the elongation of the segments already formed, partly to growth in the region of segment-formation; these specimens, however, appear to be less contracted than the Metatrochophore. The whole of the body is now segmented, though the two last segments (the fourteenth and the anal) do not bear parapodia. The remaining segments, however, especially those nearer the anterior end, bear appendages which show all the characteristics of those of the adult—foliaceous large dorsal and smaller ventral cirri, and a ramus bearing a tuft of jointed setae of the type shown in Pl. II., fig. 9. In some of the tufts a single capillary seta appears to be present also, but I have been unable to distinguish with absolute certainty between this and the appearance presented by the narrow edge of an unusually long distal segment of a compound seta, whose proximal segment is entirely embedded in the ramus of the parapodium.

The four tentacular cirri of the first three segments have developed unequally, those on the peristomial segment and the ventral pair on the second segment being now shorter than the other two pairs. The ventral cirri of the third segment are not tentacular like the dorsal ones, but resemble those of the succeeding segments.

The prototroch is still conspicuous, and the telotroch rather more strongly developed than in the previous stage.

The pharynx has almost assumed its ultimate character. The eyes are very conspicuous. Of cephalic tentacles, one pair is visible projecting sideways from the anterior end of the head; these are short, slender, and very transparent, so it is probable that a second pair is also present (as in the living specimen about to be described) obscured from sight by the tissues of the head.

Features of the living Nectochaeta.—The gut was of a clear green colour, and full of globules of some (nutritive ?) substance. The external tissues were brownish and more opaque, the anal segment being distinctly darker than the rest.

The prototroch consisted of long cilia 80μ in length —possibly there are shorter cilia as well. The cilia of the telotroch were 60μ long, and a complete amphitroch of 15μ cilia encircled every segment in a plane just behind the equatorial.

Two pairs of cephalic tentacles were present, one pair situated slightly anterior, and the other slightly ventral, to the eyes; they were short and transparent; no median tentacle could be distinguished. There appeared to be an akrotroch between the eyes, but this could not be seen at all distinctly.

Except for the absence of the median cephalic tentacle, these Nectochaetae closely resemble *Eulalia* (*Eumida*) *sanguinea*, a species that has been found at Port Erin in a condition of sexual maturity at about the time when these larvae occur, and to which they may belong: for although the median tentacle is one of the distinguishing characters of the genus *Eulalia*, it is conceivable that it might not develop until a later stage.

Phyllodocid C.—Only a single larva of this species was obtained. This has eleven pairs of parapodia; and now that the larva is fixed, the ramus of each parapodium is about twice the length of the thick conical dorsal and ventral cirri. In species *B*, which it resembles in size, the cirri project beyond the ramus in fixed specimens. No tentacular cirri are present, and the first pair of chaetigerous appendages appear to belong to the peristomial segment, characters which separate this form from all other Phyllodocids known to me. The setae resemble those of species *B*, but are slightly stouter. When alive, two pairs of short transparent tentacles could be seen close to the anterior end of the head, as in the other Phyllodocid larvae of this stage; these tentacles have completely disappeared from view now that the specimen is mounted.

There is a single pair of brownish eyes, and during life the mouth and prototroch were bordered with opaque black pigment, which was also present on the ventral surface of the prostomium, and, more abundantly, on the posterior surface of the anal segment. The gut was purplish in colour.

During life the cilia on this specimen were exceptionally easy to distinguish. The prototroch consisted of two rows of cilia, those of the anterior row being 20μ in length, and those of the posterior row 100μ. The akrotroch (Pl. III., fig. 39, A and B) was **T**-shaped, and its cilia were 20μ long; at the posterior end of its median limb cilia 40μ long were present between the shorter ones; they were not formed into the unpaired "hook" as in the larva of *Phyllodocid A*, but as their ends were beginning to macerate slightly, it is possible that they may normally be so arranged. The lateral pieces of the akrotroch curved backwards slightly, close to their origin, so as to pass behind a pair of well-defined "hooks" of 40μ cilia, and then curved forwards again as shown in the figure. Cilia were still present round the mouth, and a remnant of the telotroch remained on the dorsal surface of the anal segment. The neurotroch, however, was not present.

McIntosh (1869) has described the early stages of the development of *Phyllodoce maculata*; he figures a third-day Trochophore which is almost identical with the Phyllodocid Trochophores described above except in size, McIntosh's larvae being very much smaller* than even Species *A* of the Port Erin Phyllodocids. Agassiz (1867: pp. 249-252; Pl. VI., figs. 46-55) describes the later development of this species. His youngest larvae (his figs. 46-47) already bear a pair of eyes and one pair of short cephalic tentacles. The first three body-segments —i.e., those that ultimately bear tentacular cirri—are at first much larger than the rest, which they overlap as a "shield." Greef (1879: pp. 255-6; Pl. XV., figs. 3-9) also describes a Phyllodocid larva with a "shield."

Häcker (1896: pp. 84-6; Pl. III., figs. 8-9) describes a short row of cilia just behind the eyes of his Naples Phyllodocid larvae in the trochophore and metatrochophore stages, stating (p. 85) that these are characteristic of Phyllodocid larvae generally, and serve amongst other characters to distinguish them from the larvae of *Polynoë* and of *Nephthys*. I have been unable to detect these in the Port Erin Phyllodocid larvae, whereas they are certainly present in Polynoid larvae (see above, p. 12).

I have already referred (see above, p. 1) to Mr. James Hornell's account of a Phyllodocid larva from the L.M.B.C. district. Other Phyllodocid larvae (all of them of the same general type as those from Port Erin) have been described by Claparède and Mecznikow (1869: pp. 189-191; Pl. XV., figs. 2-2D), Häcker (1898: pp. 11-12; Pl. I., fig. 5), and Leschke (1903: pp. 130-131; Pl. VII., figs. 3-5). McIntosh (1908: p. 45) briefly summarises the accounts given by some of the authors above referred to.

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* Specimens of the metatrochophore and nectochaeta stages of this species were abundant at Plymouth at Easter (1909), and I found them to be of quite a large size—about equal to that of Phyllodocids *B* and *C*. I have no doubt of the identity of these larvae, which closely agreed with Agassiz's figures, and which developed into small worms with all the characters of *P. maculata*; there must, therefore, be a considerable amount of growth between the stages reared by McIntosh from the eggs of this species and the early metatrochophore stages seen at Plymouth.

NEPHTHYDIDÆ (Pl. III., figs. 10, 11).

One of the commonest Polychaet larvae in the Port Erin plankton during July resembles closely in form and setae the well-known larvae of *Nephthys*, to which genus I have no hesitation in referring it. The examination of the living larvae was, however, insufficient, and I cannot give as complete an account of them as of some others. This examination was, moreover, confined to larvae in the nectochaeta stage, the metatrochophore stage being seen after fixation only.

Metatrochophore.—The youngest larvae seen are pear-shaped and 500μ in length by 350μ greatest breadth, this coinciding with the position of the prototroch. The mouth is certainly surrounded by short cilia. The lateral masses of nervous tissue in the preoral lobe are well developed, and the walls of the oesophagus are much thickened, but not pouched as in Polynoë larvae.

The body shows a posterior unsegmented region and seven primary segments (Pl. III., fig. 10), which as yet can hardly be said to bear appendages, though in segments 2-7 it is just possible to distinguish lobes representing neuropodium and notopodium, setae being just visible in the former, but barely projecting beyond the soft tissues. A telotroch is present.

During the second metatrochophore stage the umbrella is reduced to about ·25μ diameter, and the appendages (with their setae) develop from before backwards, except for those of the peristomial segment, which arise much later than those of the second segment.

Nectochaeta.—This stage may be said to commence when the setae of the peristomial segment appear. The umbrella, as noted above, is now only 25μ in diameter, i.e., very little broader than the rest of the body. The prototroch consists of an anterior row of short

(20μ ?) cilia, and a posterior double row of unequal cilia as in the Syllid larvae described above. Of the latter row, those cilia which are directed forwards are about 80μ in length, and those which project backwards are much shorter (30μ ?). The length of the larva (which still shows the seven primary intertrochal segments only) at the beginning of the nectochaeta stage is about 700μ; its breadth (exclusive of the appendages) is 230μ. The first segment bears uniramous parapodia; the remaining six all show well-marked neuropodia and notopodia, each with a tuft of capillary setae, some of which are smooth, others frilled (see Pl. III., fig. 11A).

The posterior unsegmented region is longer in this stage, and bears a telotroch of 80μ cilia. A short median caudal appendage, transversely constricted in the middle, is present. The walls of the oesophagus are greatly thickened in this larva, and still stain very deeply.

A pair of almost black eyespots—purplish by strong transmitted light—is present on the dorsal surface of the head; and immediately behind them a conspicuous coiled tube is visible in living specimens. The mouth is small and inconspicuous; it is surrounded by a very narrow tract of 10μ cilia. A few cilia 15μ long are usually, but apparently not always, present at the base of the neuropodium, between this and the notopodium on every segment except, probably, the first two. Reddish-brown pigment is present on the ventral surface of the prostomium and on the anal segment; also, in a more diffuse form, on the intertrochal segments. The gut contains bright yellow globules, but is chiefly coloured by a bright blue pigment that is more intense at either end than in the middle of the body.

The oldest larva obtained is of about the same width as the last, but has increased in length to 800μ, and shows nine intertrochal segments; the secondary appendages are developing in regular series. The rudiments of a pair of tentacles can just be recognised in a pair of slightly projecting lobes at the sides of the head. Both the prototroch and telotroch are still well developed, and the intertrochal cilia between the lobes of the parapodia have been seen in a living eight-segment larva; the only nine-segment larva obtained was not examined alive, and so it is impossible to say whether they are present on it or not.

The complete development of *Nephthys* from the Trochophore has been described by Fewkes (1885: pp. 180-184; Pl. IV., figs. 1-12). He states that the mouth is situated, as in the larva of *Polygordius*, between an anterior and posterior ciliated band, the latter bearing shorter cilia than the former, but differing from that found in *Polygordius* in that it becomes indistinguishable from the anterior band laterally and dorsally. Leschke (1903: p. 131) has since proved this to be the case in a European species also. His posterior (post-oral) band is not present in the Port Erin larvae. Fewkes' oldest specimens—ten chaetigerous segments—show the development first of one and then of the rudiments of a second pair of cephalic tentacles, whilst dorsal and ventral "cirri" appear on each of the parapodia. A telotroch is present from the trochophore stage onwards, disappearing only in the very oldest larvae. Claparède and Mecznikow (1869: Pl. XIV., fig. 3), Häcker (1896: Pl. III., fig. 5; and 1898: Pl. I., fig. 4), Leschke (1903: Pl. VII., fig. 9) and McIntosh (1908: Pl. I., figs. 1-3) have also described Nephthys larvae. McIntosh's larvae (pp. 14-16) at least seem likely to belong to the same species as do those found at Port Erin during July.

EUNICIDÆ (Pl. I., fig. 21).

A Eunicid Metatrochophore has been twice seen. It differs from all other larvae here described in that it bears the cilia characteristic of a Protrochophore, the true trochophore stage having been omitted from its life history.

The larva (Pl. I., fig. 21) is ovate; it is 300μ long by 180μ broad; and is invested in a thick ornamented cuticle, the ornament being, however, no longer visible when the specimens have been mounted in balsam. Cilia 15μ long project beyond the cuticle all over the body with the exception of a narrow tract round the apical tuft of 30μ cilia, and a somewhat larger area round the anus. Close to the posterior border of the broad ciliated region there is a pair of lateral tufts of 30μ cilia.

At the apical pole the cells take a deep stain; behind this there is a faintly-staining tract; and behind this again, on the ventral surface, there is another deeply-staining area, in which can be distinguished the outlines of the three primary segments and the formative region, the last being quite narrow in the younger of the two specimens, but almost as broad as one of the primary segments in the older of the two. Behind this, finally, there is in the older larva at least, a narrow band of clear tissue surrounding a cluster of deeply-staining cells at the extreme posterior end.

A number of short straight rods were seen during life directed towards the surface under the cuticle at the anterior end of the larva. A pair of red eye-spots were present near the anterior end. The gut was tinged with traces of a pinkish pigment, and contained large clear globules.

In the older larva at least, setae project from three pairs of cavities in the cuticle; these setae can be retracted into pits in the body-wall. They are all compound, but do not now show sufficiently clearly in balsam to allow an accurate drawing to be made.

Eunicid Metatrochophores very similar to the above have been described by Häcker (1896: pp. 78-9; Pl. III., figs. 3-4, and 1898: p. 9; Pl. I., fig. 2). His 1896 paper includes a description and figure of the Nectochaeta, as well as the Metatrochophore of the Naples species.

Other Eunicid larvae have been described by Claparède and Mecznikow (1869: pp. 182-4; Pl. XV., figs. 1-1H—? *Lumbriconcreis.* And pp. 184-186; Pl. XII., figs. 2-21—*Ophryotrocha*), Wilson (1882: pp. 288-291; Pl. XXI., figs. 89-92; Pl. XXIII., fig. 10—a very complete account of the development of *Diopatra cuprea*), Fewkes (1885: pp. 197-201; Pl. VII. and Pl. VIII., figs. 1-3—*Lumbriconereis*; stated to be generically different from the ? *Lumbriconereis* of Claparède and Mecznikow), Braem (1893: pp. 217-221; Pl. XI., figs. 32-36—*Ophryotrocha*) and Korschelt (1893: pp. 237-242; Pl. XIII., figs. 12-15—*Ophryotrocha*). All these larvae agree in the suppression of the trochophore stage; but this is apparently due to the first portion of their development taking place within a mass of jelly, and is not at all exclusively characteristic of the Eunicidae (see Häcker, 1896). With the exception of *Ophryotrocha*, there is, however, a marked resemblance between them in general form.

II.—SPIONIFORMIA.

The larvae of Spioniform worms (with the exception of the Chaetopteridae, whose well-known "mesotrochal" larvae form a well-defined group), are characterised by the presence of long capillary provisional setae, of which those of the first segment considerably exceed the others in length, and often appear in the trochophore stage. The segmented larvae are in general much more slender than those of the Nereidiformia, and the characteristic pair of tentacles usually begin to develop immediately behind the prototroch, at an early stage.

SPIONIDÆ.

Spio. (Pl. III., fig. 38).—Metatrochophore.—The youngest larvae seen are of a small size (300μ by 100μ), and bear three pairs of very conspicuous black eye-spots that are very resistant to the solvent action of spirit. The eyes may be arranged in a straight line with the large, somewhat crescent-shaped pair at the sides of the head and the other two pairs nearer the middle-line on the dorsal surface; or their position may, in the same specimen, change so as to present the arrangement shown in Pl. III., fig. 38, or some intermediate pattern.

Each segment bears a tuft of exceedingly long and slightly curved setae, which are held parallel to the sides of the body when the larva is swimming, but when it is irritated they project from the body as shown in Pl. III., fig. 38. These setae are minutely serrate on the convex side, but the serrations are quite indistinguishable in a balsam mount. As the larva grows they increase in length also, so that the longest ones are always found to be about twice the length of the body. The oldest larva seen has eight segments, and is 550μ in length.

The observations upon this larva during life are not sufficiently complete to allow of the structures then seen being adequately figured; but apical cilia and (incomplete?) interparatrochs are certainly present. The prototroch seems to be invariably composed of shorter cilia (40μ) than the telotroch (50μ). The course of the prototroch is interrupted in the middle of the dorsal surface (see figure). It is continued downwards, to end ventrally on each side on the lips that border the capacious "mouth." The formation of these lips shows that it is not the mouth of the Trochophore, but is the external aperture of a vestibule from which the original mouth still opens into the oesophagus. This structure, which further involves the modification of the ciliated bands on the head and anterior segments, appears to be characteristic of larvae of the Spionidae and Polydoridae. It is described for several of these larvae in another paper (Gravely, 1909).

This larva resembles certain known larvae of *Spio*—so closely as probably to be of the same genus—perhaps also of the same species as some. Of these larvae, one reared from the ova of *S. fuliginosus* is figured by Claparède and Mecznikow (1869: Pl. XII., fig. 1M; and Cambridge Natural History, Vol. II., fig. 145B, p. 275) with its setae, which are not quite so inordinately long as in the Port Erin form, held as when swimming. In the larva of *S. meczníkowianus*, also figured by these authors, the gut is enormously swollen with food-yolk, the larva being at first carried about attached to the body of the mother. The larva of *S. seticornis* described by Leschke (1903: pp. 122-3; Pl. VI., figs. 7-9) and the *Spio* larva described by Häcker are both very like the Port Erin form above described.

Spionid A ("Claparède's unknown larval Spio") (Pl. II., figs. 22-27).—A transparent, colourless larva, originally described by Claparède (1863: pp. 77-80; Pl. VI.) and subsequently—under the name quoted above—by McIntosh (1894: pp. 71-74; Pl. VIII., figs. 4-7), is very abundant in almost every tow-netting taken at Port Erin during July. Although I am able to describe a later stage in the development of this larva than either of the above writers have done, its identification with an adult form still remains an unsolved problem.*

Nectosoma.—The earliest stage obtained was 700μ long by 200μ broad. It shows a posterior unsegmented region preceded by about ten somewhat indistinct segments. The first of these is provided with a tuft of long straight setae, and the others with shorter but otherwise similar ones; no neuropodial setae are present as yet. The body-wall is thin dorsally, but thicker ventrally. The gut is broad, and contains a (yolky ?) substance of finely granular appearance and faint staining properties with borax-carmine. No food-material from the exterior has been seen in the gut in the earlier stages. The head is rounded in front, and after fixation is almost always ventrally flexed. Young specimens examined alive bore two pairs of red eye-spots on the dorsal surface of the head, the inner pair being situated somewhat behind the outer pair. They also showed a spot of opaque yellow pigment at the base of each tuft of setae; these spots were smaller towards the anterior end of the larva than they were towards the posterior end; and a line of minute specks of the same opaque pigment was found to extend across each segment between the spots situated on either side of it.

The larvae elongate by the continuous development of new segments, and the boundaries of the old segments become more clearly defined. The neuropodial setae soon appear, the first of each tuft to develop being very much stouter than the rest, which resemble those already present

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*Dr. Allen has called my attention to the fact that Claparède himself subsequently described (*Zeits. wiss. Zool.*, XXV., 1874—included in a paper by Ehlers) fragments of a worm which he recognised as the adult of this larva, and for which he founded the genus *Poecilochaetus*, a genus separated from the Spionidae by Mesnil and placed in his new family Disomidae. Dr. Allen has since fully described a species of *Poecilochaetus* (*Quart. Journ. Micr. Sci.*, XLVIII., 1904).

in the dorsal tuft. Before long a similar stout seta appears in the dorsal tuft, and two may be present in the ventral one. The most anterior segments, however, seem to be without these stout setae.

In a larva of about twenty segments (1,500μ long) a pair of lobes, the rudiments of the tentacles, are clearly indicated at the sides of the head, and parapodia, slightly biramous, already project from the surface of the body, though more usually this occurs in larvae of about twenty-five segments. The tips of both lobes of the parapodia are faintly tinged with brown; and each of the masses of opaque yellow pigment above mentioned is now situated between the bases of the two lobes of a parapodium (Pl. II., fig. 27). The individual segments lengthen considerably at about this time, and the tissues lose the strikingly embryonic appearance that they have so far possessed, at all events after staining. This is due in part, no doubt, to the disappearance from the gut of its (yolky ?) contents referred to above; only occasionally, however, has any food material from the exterior been seen to replace this substance.

The head and anterior segments show, in an intensified form, the structures briefly noted above (p. 33) as characteristic of larvae of Spionidae and Polydoridae. There are no nototrochs; gastrotrochs, however, are present on every segment, but become smaller, and finally disappear towards the posterior unsegmented region. The gastrotrochs of the first three segments are modified in connection with the special characters of the head; those of the remaining segments consist on each side of an outer and middle row of 40μ cilia, and an inner row of 15μ cilia; the inner rows of the two sides of one segment do not extend to the middle line, but are separated by a short gap, as are the other parts of the gastrotroch. There is a short median dorsal gap in the powerful telotroch.

The dorsal and ventral rami of the parapodia increase in size, whilst the pigment spots between them decrease. When about thirty segments have appeared, the parapodial rami of segments 7-11 (inclusive) rapidly lengthen till they become 200μ long, those of the other segments retaining a length of about 100μ; the former are now shaped like a long-handled club, attached by the thick end (Pl. II., fig. 26, shows one of these parapodia from a still more advanced worm); the latter lack the "handle," and are simply pear-shaped.

In this connection it may be noted that the correlation between the development of any particular organ and the number of segments then present is remarkably small, and Claparède figures a forty-segment specimen with uniform appendages. When about forty segments have been formed the Port Erin larvae are found to have developed a pair of large tentacles that project conspicuously from the sides of the head; between them the dorsal surface is compressed laterally so as to give the head a crested appearance. All cilia disappear from the larva, with the exception of some situated in a pit on the ventral side of the second segment, and a row placed obliquely on each side of the median dorsal crest of the head.

Further specialisation of the appendages takes place. The first segment (Pl. II., fig. 23) bears on each side as before a bunch of much longer setae than the following segments; immediately behind these setae, and apparently belonging to the same segment, is a short (40μ) notopodial projection, below which is a small (30μ diameter) spherical protuberance, which during life bears straight delicate (sensory ?) processes; and immediately behind this protuberance is situated a tuft of short (800μ) setae, and a long (130μ) neuropodial projection. The second and third segments (Pl. II., fig. 24) each bear a long (130μ) notopodium immediately behind a bunch of short (500μ) setae; and a neuropodium of the same dimensions as the notopodium. Immediately in front of the neuropodium is a tuft of setae consisting of a single straight seta, and first one, then two, and in the oldest specimen of all (in the anterior of these segments at least) three shorter stout curved setae. Between the dorsal and ventral rami there is a small round protuberance bearing hair-like processes as on the first segment. The fourth, fifth and sixth segments (Pl. II., fig. 25) resemble the second and third, except as regards the ventral bunch of setae, which consists of two straight stout spines and three or four much smaller ones; the small rounded protuberance, moreover, is not invariably present on all these segments. The next five segments (Pl. II., fig. 26) resemble the last three, except that both neuropodium and notopodium reach a length of about 200μ, being produced distally, as mentioned above, into a slender cylindrical "handle"; one of the dorsal setae, too, is markedly stouter than the rest, resembling the two strong setae of the ventral bunch. The remaining segments also show this stout dorsal seta, but otherwise resemble segments 3-5; after the first four or five of them, however, the occurrence of these special setae becomes irregular, and still nearer the posterior end they are not to be found at all.

Two fixed specimens--one incomplete at the posterior end, the other with forty-two segments—show the anterior unpaired process of the head (Pl. II., fig. 22) developing to a large size; its distal end is flattened, but not bifid. McIntosh (1894: p. 73) remarks that none of Claparède's or his own specimens showed this conspicuously, and suggests that it might be expected later to attain a much greater size. These two larvae appear to be considerably older than any described by either Claparède or McIntosh, as these authors make no mention of the short curved setae of segments 2-3, which would seem to develop some time before the growth of the anterior prolongation of the head.

I have seen nothing, even in the oldest larvae, of the two rudimentary cirrus-like outgrowths that occurred on each parapodium of the second and third segments in a specimen described by Claparède from Christiansand Harbour (1863: p. 79; Pl. VI., figs. 8-9). Probably these were, as he suggests, abnormal.

Spionid B (Pl. III., figs. 33-34).—Nectosoma.—This larva is characterised by its slenderness, the anterior segments of a well-expanded specimen being quite as long as they are broad.

The youngest specimen examined (800μ by 80μ) shows ten segments and a posterior unsegmented region; the appendages scarcely project, and the setae, which are long and slender, have become so much folded round the body in mounting (this larva was not examined alive) as to make further observations upon them impossible. The head is rounded in front and already bears two pairs of eyes, a small pair situated on the dorsal surface not far from the middle line, and a larger pair situated at the sides of the head or slightly on the ventral surface. Prototroch, telotroch, and intertrochal cilia are present, but their extent cannot be determined. Close to the anus there is a pair of very characteristic groups of anal styles (Pl. III., fig. 34; *An. sty.*). Later stages show the growth of the worm by the addition of further segments; a very conspicuous pharynx appears (Pl. III., fig. 33; *Ph.*), the tentacles develop, and both notopodia and neuropodia begin to project from the sides of the body. A mounted larva of twenty-two segments (total length 2,100μ, breadth 150μ) shows the setae very clearly (Pl. III., fig. 33). Those of the (single ?) tuft on the first segment reach a length of 450μ, whilst those of both dorsal and ventral tufts on the second and third segments are not more than 80μ long; the fourth and succeeding segments bear setae 300μ long, these being less numerous on the fourth than on the remaining segments; they are provisional setae that are shed from the anterior segments—with the exception of the first—before they disappear from the posterior ones. The provisional setae of the first segment disappear very soon, however, and those of the remaining segments continue to be shed, from before backwards. The permanent setae become more numerous, and hooded crotchets make their appearance in the ventral tufts of setae on the tenth and succeeding segments, being most numerous near the posterior end. The branchiae and podal membranes develop in series beginning on the second chaetigerous segment.

My observations upon this larva in the living condition were confined to the stage in which the tentacles, though present, are still rather short. The usual Spionid characteristics of the anterior end (see above, p. 33) are present. The prototroch extends along the bases of the tentacles. The head presents a crested appearance, as in the advanced stages of *Spionid A*. Gastrotrochs, broken into four equal sections, are present on every segment, with the possible exception of the first three as in "Claparède's larva" (see above, p. 35). The telotroch is incomplete dorsally, as in other Spionid larvae. The tentacles of this larva, as well as its slender vermiform appearance and long provisional setae, show it to be undoubtedly a stage in the development of a

Spioniform worm; it differs, however, from all the figures I have seen of such larvae in the length and narrowness of the segments, and the consequent extreme slenderness of the larva as a whole. Otherwise it is not unlike the larva of *Nerine* figured by Agassiz in 1867 (see his Pl. VI., figs. 40-42) and de Saint-Joseph (1894: p. 69; Pl. III., fig. 80). The generic characters (see Mesnil, 1896, p. 117) of our larva up to the latest stage examined are those of *Microspio*, Mesnil, but as several of these are negative its position cannot be regarded as definitely established.

[**Nerine.**—An early stage of *Nerine cirratulus* is very common at Port Erin, more especially, Mr. Chadwick tells me, in the earlier part of the year. I have not yet been able to make any detailed observations upon it, although I have frequently seen it in the July plankton; and I have not been able to trace its history after the loss of the conspicuous vitelline membrane with which these early stages are invested. Its identity has been determined by Cunningham and Ramage (1887: pp. 638-9), who recognised this vitelline membrane with its characteristic external reticulum of hexagonal meshes to be the same as that originally described by Claparède (1868: pp. 329-330) surrounding the ova of *Nerine cirratulus*.* These authors describe the segmentation of the egg and the development of the Trochophore, which still bears the characteristic vitelline membrane (Pl. III., fig. 39, C) through which pass the cilia of the prototroch, telotroch, and apical organ. Two pairs of chaetigerous parapodia begin to develop before the vitelline membrane disappears; the setae of the anterior pair are, as is usual

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* I have found a similar membrane round the eggs of *Scolecolepis vulgaris*; so these larvae may belong to either of these worms, and perhaps to others also.

in Spioniform larvae, much longer than those of the second pair. Leschke (1903: p. 103; Pl. VI., fig. 10) has also described the Trochophore of this species; his account is in close agreement with that of Cunningham and Ramage. Claparède and Mecznikow (1869: Pl. XII., fig. 4) figure a two-segment larva of this species, still invested in the vitelline membrane; it is apparently of about the same age as that figured by Cunningham and Ramage in fig. 2 G of their Pl. II. Claparède and Mecznikow state that the further development is broadly the same as that of "*Nerinen* (fälschlich *Leucodoren*) Larven von Normandie," and only figure one other stage, this having over thirty segments. This larva is at once distinguished from the Spionid larvae of the present paper by the large prickles on the provisional setae of the first segment. The figures given by Cunningham and Ramage (loc. cit.: Pl. XXXVII., figs. 2 I, 2 J) show "a later stage [12-segments; not described in the text] of the larva" of *N. cirratulus* which has developed along very different lines from this larva, but resembles in some detail the larvae of *Polydora* (see below, p. 53).]

Spionid C. (Pl. III., fig. 35). This is an extremely common form, characterised by its small size (about equal to that of similar stages of the *Spio* described above), long slender setae, and single pair of eye-spots, which are situated slightly on the ventral surface and which always disappear in spirit. I have only been able to make a hurried examination of the living larva.

Metatrochophore.—The head is rounded and bears a tuft of apical cilia and one pair of red eye-spots. The prototroch is probably still complete at this stage, as the characteristic cephalic larval organs of the Spionidae do not seem to have developed as yet; it encircles the larva in its broadest part, which is 150μ in diameter.

Behind it successive segments are formed, narrow at first, but becoming broader as they develop; each bears a dorsal tuft of long (240μ) setae, and a ventral tuft of shorter ones (80μ), the latter appearing on each segment a little later than the former. The lengths of these setae show a steady decrease from the first segment to the posterior end. Gastrotrochs were seen in the living larva, but their precise extent was not determined.

The dorsal body-wall is thin as usual, and contains a pair of conspicuous longitudinal muscle bands; the ventral wall is thicker, and even in quite small larvae (seven segments) shows traces of the differentiation of the nerve-cord which, during the development of the next two or three segments, becomes quite clearly defined. The gut, even in the earliest stages seen, contains the remains of unicellular organisms. No distinctive permanent features have been seen in this larva, only the metatrochophore stage having been found. On account, however, of the long setae and slender body it may be referred with certainty to the Spioniformia. It can hardly be an early stage in the development of *Spionid A* because, in addition to its relatively small proportions, the gut always contains abundant remains of unicellular organisms and never the yolky (?) material there present. From *Spionid B* it is distinguished by the shortness of the segments relatively to their breadth; the setae, too, are slightly stouter and more rigid.

Spionid D.—" Chaetosphaera "—(Pl. III., figs. 36-37).

Metatrochophore and Nectosoma.—This is a very large form, which is characterised by its tufts of strong, smooth, and slightly curved setae (Pl. III., fig. 36), and by the prolongation of the head into a snout which, however, is usually contracted out of all recognition in fixed specimens (compare Pl. III., figs. 36 and 37).

This snout appears to be formed from the anterior margin of the head and lips, and is a peculiar modification of the cephalic larval organs characteristic of the Spionidae.* Sections have revealed the presence of a curious (sensory ?) organ, situated on the fore part of the head in the mid-dorsal line immediately above the brain. Behind this are situated the eye-spots, which are of a reddish colour and somewhat opaque.

Nototrochs are absent. The gastrotrochs of the anterior segments are as usual modified in connection with the special structures of the head. The fourth and succeeding segments, however, each bear laterally an inner and outer pair of short rows of extremely powerful 100μ cilia on the ventral surface; whether any cilia were present nearer to the middle-line it was impossible to determine on account of the extreme opacity of this region in the larvae examined. These gastrotrochs became smaller and finally disappeared altogether towards the posterior end of the body. The cilia of the telotroch were much longer than those of the prototroch, the former being 120μ long, the latter only 60μ. The tentacles develop at a very early stage, and the prototroch extends along their bases (Pl. III., figs. 36-37, *Ptr.*). The gut consists of a muscular pharynx followed by a broad intestine which is filled with a very opaque yolky material; the walls of the gut often contain dense black pigment.

The provisional setae are very stout and distinctly curved. Those of the first segment reach a length of 300μ, those of the remaining segments a length of 200μ; they are confined to the dorsal lobe of each parapodium, and appear before the parapodia begin to project from the body-wall. The ventral setae develop later; they are

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* It has been described elsewhere (Gravely, 1909).

short capillaries, and separated from the dorsal tuft by a small conical process which precedes them in development. These parapodial structures are well shown in a mounted larva, of about 17 segments, which is 1,300μ long by 300μ broad; many of the ventral setae have reached a length of 90μ; they are smooth (?), stout, and slightly curved, and occur three or four to each tuft, the provisional setae being still present in the dorsal tufts. In another larva of about the same age most of the provisional setae have been shed from all segments (except the first) of the anterior half of the body, their place being taken by permanent dorsal setae resembling those of the ventral tuft in which the development of provisional setae appears to be entirely omitted. In this specimen crotchets are present in the ventral tufts of the thirteenth and succeeding segments; the gut is still full of opaque yolky material.

These larvae probably belong to the same species as the "Larve mit rüsselartiger Oberlippe" figured by Claparède (1863: Pl. VII., figs. 1-2) and briefly described in a foot-note to p. 86 of the same work. The unpaired dorsal (sensory ?) organ on the fore part of the head is indicated in his fig. 2.

Another species of larva* showing the same remarkable modification of the head, and the same arrangement of the ciliated bands, occurs in the Plymouth plankton at the end of March and beginning of April. Many of the setae of this larva are very much stouter than those of *Spionid D*; some of them are smooth, and others serrate, the former presenting a variety of form strongly suggestive of the figure given by Häcker (1898: Pl. III., fig. 21) of one of the larvae for which he created the provisional (larval) genus "*Chaetosphaera*." The stout and diverse form of the setae, together with the habit which the Plymouth larva shares with *Spionid D* of contracting and curling up into a more or less spherical spinose mass when irritated, proves conclusively that the Plymouth larva is a true "*Chaetosphaera*," and from this it may be inferred that the peculiar structure of the head found in the Plymouth larva and in *Spionid D* is one of the characteristics of the genus. As Häcker was only able to examine preserved specimens, it is not surprising that he saw nothing of this. The simpler stout setae which alone are found in *Spionid D* bring this larva nearer to the species of "*Chaetosphaera*" figured by Häcker (loc. cit., p. 20) in his text-figs. C and D; this, however, bears serrate setae anteriorly, whereas the setae of *Spionid D* are all smooth.

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* These observations on *Chaetosphaera* were made after the above account of *Spionid D* had been written. As this paper in its original form is frequently referred to in my 'Studies on Polychaet Larvae' (Gravely, 1909) it seems best to add this note rather than modify the original account.

A specimen of another species of "*Chaetosphaera*" was obtained by Prof. Herdman at Port Erin in April, and this he kindly sent on to me; but as it is at present only known by this one preserved specimen I cannot give a full description. The general form of the body is like that of *Spionid D*, but the "snout" is of course contracted beyond recognition. Most of the setae resemble those of *Spionid D* in form, but are serrate instead of smooth; amongst these a single broad, flat, and somewhat curved seta, with rather finely serrate edges occurs in some of the dorsal tufts. Though broad at the base it becomes much broader distally, and then rapidly tapers to a point, the outline of the tip consisting of a pair of somewhat concave curves. The eyes are four in number.

With regard to the adult form of "*Chaetosphaera*," it is interesting to note that a slender median tentacle, inserted ventrally in the dorsal sheathing portion of the prostomium, was found to be developing in the oldest of the Plymouth larvae that were seen. A tentacle in this position is found in the Spioniform worm *Poecilochaetus*, but any close affinity with this genus is rendered improbable by the entire absence from the larva of *Poecilochaetus* (*Spionid A* of this paper)—unless it be in the very early stages prior to that in which it first appears in the tow-net—of the cephalic structures characteristic of the "*Chaetosphaera*" larva. At present it is impossible to identify the larval genus "*Chaetosphaera*" with any known adult genus, but the many points of resemblance between this genus and the larvae of *Spio* and *Polydora* sufficiently prove it to belong to the Spioniformia.

POLYDORIDÆ.

Polydora.—Metatrochophore (Pl. II., fig. 31).—A species of Metatrochophore resembling that described by Claparède (1863: pp. 69-70; Pl. VII., figs. 4-6) as the young of *Leucodora*, Jnstn. (=*Polydora*, Bosc.) *ciliata* was obtained on several occasions; in no case, however, have I seen a specimen intermediate between these larvae and either form of *Polydora* Nectosoma described below. None of these Metatrochophores have been examined alive; when fixed they appear to be very much contracted. A 5-segment specimen is 350μ long, its maximum breadth (300μ) occurring in the body-region. The head is large, and almost hemispherical in shape; it is 200μ broad posteriorly, and bears the rudiments of a pair of tentacles. Claparède, in his 5-segment stage, figures a powerful prototroch and telotroch, a band of shorter cilia situated on the fifth segment, the rudiment of a neurotroch on the first two segments, and a pair of short tufts of cilia on the anterior margin of the head. His larvae are certainly not specifically identical with the Port Erin ones however, and whether these structures are also present in them is yet to be ascertained. The first segment of the Port Erin larvae is longer than any other and bears a pair of tufts of long (850μ), stout, curved, ringed setae (Pl. II., fig. 31), with a short parapodial process in connection with each. The remaining intertrochal segments each bear a discontinuous transverse band of black pigment. They are usually devoid of setae; but in one larva a single pair is present on the fifth (?) segment; these two setae are much shorter and more slender than those of the first segment, and they appear to be quite smooth. Claparède figures ringed setae on all segments in his 5-segment stage (loc. cit., fig. 6), those of the four posterior segments being about half the length of those of the first segment; he also figures the pigment as a stellate patch on each side of the four posterior intertrochal segments, and not in transverse bands as in the Port Erin larva.

Nectosoma.—Two species of *Polydora* have been found in the nectosoma stage. One of these (described under the name "*Polydora B*") bears pigment arranged, roughly, in transverse bands (see fig. 32); it is possible that this may be a later stage of the Metatrochophore above described, but as all the specimens obtained show 15-20 chaetigerous segments it is impossible to find any certain evidence of this. The other species is much commoner and is characterised by stellate pigment-patches, arranged in a row down the middle of the dorsal surface of the body. As much more complete series of these larvae have been found it will be convenient to describe this species (to be referred to as *Polydora A*) before the other.

Polydora A (Pl. II., figs. 28-30). The youngest specimen obtained is 580μ long by 150μ broad, and has nine segments. A short conical parapodial outgrowth is present immediately below each tuft of setae. The setae are smooth capillaries, those of the first segment being decidedly longer than the rest. The tentacles have not yet developed, which proves that this is not a later stage of the *Polydora* Metatrochophore described above. The head bears three pairs of eyes enmeshed in a reticulum of black pigment (as in Pl. II., fig. 28, a later stage). Black pigment is present at the sides of the body, between the tufts of setae; on the third, fourth, and fifth segments a black band passes dorsally from each of these lateral patches, the anterior pair almost meeting in the middle line (as in Pl. II., fig. 28). On each of the remaining segments these bands are replaced by a median ramified patch; the posterior end of the anal segment is tipped with similar black pigment. No black pigment is present on the ventral surface. In a 12-segment larva the arrangement of the pigment is as before, but the ramified patches are much larger. A few provisional setae of the ventral tuft are beginning to project in addition to the dorsal ones on some of the anterior segments. It appears to be usual for the ventral provisional setae of Spioniform larvae to develop later than the dorsal ones, and to remain smaller than them (for other instances see *Spionids A, C, D*, above).

The tentacles appear as a pair of short conical outgrowths behind the prototroch (which does not extend along their bases) in a 17-segment stage. This larva is represented in fig. 29. It will be seen that the arrangement of the pigment remains very much as before. The fifth segment shows, embedded in the tissues, the faintest rudiments of its specialised permanent setae, and has already lost a number of its provisional ones, though none of the other segments appear to have lost any of theirs.

In an older larva (2,000μ; 23 segments) the specialised setae of the fifth segment are much more conspicuous and project slightly, almost all the provisional setae having been shed from this, and from the first, second, and third segments. The tentacles are much longer and appear to arise nearer the middle line than in the younger specimen. In addition to this, the parapodia of the seventh and succeeding segments each bear a short (30μ) dorsal outgrowth—the rudiment of the gill—and amongst their ventral setae a single hooded crotchet has appeared. The lateral extensions of the first three or four median ramified patches of pigment are now emphasised by a considerable reduction of the other parts, and the lateral patches are in some instances extended for a short distance on the ventral surface. The four most recently formed segments are pigmented on the same plan as segments 3-5, the lines of pigment, however, ramifying somewhat over the segments. The five pharyngeal pouches described in detail by Salensky (Bull. Imp. Acad. Sci., Moscow, 1908) reach the height of their development at about this stage.

In the oldest specimen seen (25 segments) these pouches are disappearing again; the special setae of the fifth segment project as shown in Pl. II., fig. 30. I have been unable to identify them with those of any adult form. The shedding of the provisional setae has not progressed so far as in the previous specimen. In both these larvae, and in all others of sufficient age a number of segments, increasing with the growth of the body and commencing with segment 9, contains a deeply staining granular substance, which, in balsam preparations of whole specimens stained with borax-carmine, closely resembles developing spermatozoa.

The anterior end is modified in connection with the vestibule characteristic of larvae of the Spionidae and Polydoridae.* On the third segment a tuft of 80μ gastrotrochal cilia is present on each side close to the ventral setae; segments 5, 7, 10, 13, 15, 17, etc.—*not* strictly alternate segments anterior to the 13th—each bear a gastrotroch which consists of two kinds of cilia, a row of short (45μ) cilia extending across the middle part of the segment between two lateral rows of powerful (80μ) cilia, with which it is continuous at each end; in the more advanced larvae examined the gastrotroch of the highly specialised fifth segment, but of no others, was found to be undergoing reduction. Nototrochs are absent from the first two segments, but on all the others a line of 60μ cilia is present on each side; whether these are joined by a line of shorter cilia across the middle of the segment to form a complete nototroch I was unable definitely to determine. The cilia of the prototroch, which does not extend along the bases of the tentacles, are 80μ long; those of the telotroch, which is incomplete dorsally, are 100μ long.

Polydora B (Pl. II., fig. 32). This is most easily distinguished from *Polydora A* by the arrangement of the pigment which is more diffuse, and lacks the characteristic stellate appearance. A change in the pattern on each segment is noticeable in passing from the anterior to the posterior end of the larva. The first segment bears a pair of irregular black patches; subsequent ones bear a more or less continuous posterior transverse band of pigment, which becomes more broken

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* See Gravely, 1909, pp. 610, 611.

in the posterior segments, where, in addition, a row of irregular black patches is present in front of each.

The only other known *Polydora*-larva whose pigmentation is at all like this is figured by Häcker (1898: Pl. II., fig. 16). Three pairs of eye-spots are present, the inner- and outermost pair being larger than the middle pair; a small reticulate patch of pigment is present beside each eye of the outermost pair, but this does not extend amongst the eyes as in *Polydora A*. The ventral surface is free from this black pigment. Apparently no specimen obtained is old enough to bear crotchets; the stout setae of the specially modified fifth segment are, however, very evident, although the larvae have only 17 segments, at which stage this segment is almost unmodified in species *A*; capillary setae are still present on this segment. The specialised setae are very like those of species *A*. One larva of species *B* was examined alive; the cilia are arranged as in species *A*.

Claparède, as above mentioned, has described the development of larvae which he believed to be those of *Leucodora*, Jnstn. (=*Polydora*, Bosc.) *ciliata*. Agassiz (1867: pp. 242-3) disputes the identity of these larvae with this or any other species of the genus *Polydora* on account of the complete absence of the special modifications of the fifth segment, even in the oldest larvae; and he goes on to describe the development of a species of Polydora—probably, he thinks, *P. ciliata*—from an 11-segment form (loc. cit., Pl V., fig. 26), in which "the fifth ring is much wider than any other, and has only three short, stout bristles on each side" (loc. cit., p. 244). Agassiz's main contention, however, falls to the ground in view of the fact that Claparède's oldest larva possessed only 17 segments, at which stage, as noted above, it is only after a careful examination with a high power, of a transparent mount, that traces of the special modifications of the fifth segment can be distinguished in *Polydora A*. Thus the stage at which these structures appear may be much later than was the case in the larvae examined by Agassiz; and this variability has also been noted by Häcker (1898: p. 17) in connection with certain species described by him. Apart from the question of the fifth segment, however, Claparède's 17-segment larva is much more fully developed than even the most advanced of the Port Erin forms; and the one serious difficulty that I see in including it definitely in the genus *Polydora* is that all the segments appear to bear normal short permanent capillary setae, *the fifth segment bearing just as large a tuft as the others.* However, as in many species of *Polydora*, there is a small tuft of capillary setae on the fifth segment in addition to the special stout setae, I think it probable that these larvae really do belong to the genus *Polydora*, for they bear gastrotrochs on segments 5, 7, 10 (*not* regularly alternate) just as in both species of Port Erin Polydora larvae, and the stellate patches of dense black pigment appear to be found exclusively in *Polydora* larvae. All known larvae of Polydora (six distinct species) possess patches of dense black pigment, and in at least four of these (Agassiz's larva of *P. ciliata*, loc. cit.; Andrews' larva of *P. commensalis*, 1891; one species of Häcker's *Polydora* larvae, 1898; and *Polydora A* of the present paper) they are large and ramified, as in Claparède's larvae, whilst in the remaining two species (one of Häcker's species of *Polydora* larvae, 1898; and *Polydora B* of the present paper) they are small, unbranched, and less definite in outline and arrangement.

Differences in the shape and arrangement of the large ramified pigment areas, and in the disposition of the gills show that Claparède's larva cannot, however, be of the same species as Agassiz's, and Leschke (1903: pp. 118-121; Pl. VI., figs. 1-6), who has described the development of *P. ciliata* from the egg, states that the larva of this species resembles those described by Agassiz. The early stages described by Leschke, moreover, differ markedly from those described by Claparède, in that the Trochophore bears no setae at all, a stage with the rudiments of three intertrochal segments (Leschke, loc. cit.: Pl. VI., fig. 4) bearing short setae, which only reach their full dimensions in the stage with three completely developed segments (loc. cit.: Pl. VI., fig. 5). Claparède himself accepted Agassiz's removal of his "*Leucodora*" larva from the genus *Polydora* (=*Leucodora*), and in conjunction with Mecznikow described another larva (1869: p. 175; Pl. XII., fig. 3) as that of *Polydora*. But the difference between this larva and Agassiz's is far greater than that between his original "Leucodora" larva and the latter; and a comparison between his figure of it, and Pl. IV., figs. 41, 42, and 43A of the present paper will prove at once that it is really the larva of *Pectinaria*, and that the special setae supposed to belong to the fifth segment are in reality the paleae of this worm, which develop internally in the position shown, and appear fully formed at the anterior end during metamorphosis as described below.

De Saint-Joseph (1894: pp. 63-4; Pl. III, fig. 73) describes a larva which he says is identical with Agassiz's larva of *P. ciliata*. The larvae figured by Cunningham and Ramage (1887: Pl. XXXVII., figs. 2I, 2J) as advanced larvae of *Nerine cirratulus*, differ greatly, as pointed out above (p. 41) from the larva of this species figured by Claparède and Mecznikow; and as nototrochs occur on every segment after the 2nd, and gastrotrochs on the 3rd, 5th, 7th, and 10th segments, exactly as in the Port Erin *Polydora* larvae (those on the 3rd segment being, moreover, rather smaller than the rest, as in the Port Erin larvae), it is likely that these also belong to a species of *Polydora*.

MAGELONIDÆ.

Magelona (Pl. III., fig. 39). Nectosoma.—The nectosoma stages of *Magelona* have been fully described by Claparède (1863: pp. 74-77; Pl. X., figs. 9-14; Pl. XI., figs. 1-2), and subsequently—under the name *Prionospio tenuis* by Fewkes (1885: pp. 167-172; Pl. I.); that Fewkes' larvae belong to the genus *Magelona* and not to *Prionospio* has been pointed out by Giard (1886: "Sur le développment de *Magelona papillicornis*"; Bull. Sci. du Nord, XVII., p. 98). McIntosh has also examined some stages in the development of this larva (1894: pp. 66-71; Pl. VIII., figs. 1-3). The youngest stages known appear to have been described by Claparède only. On Pl. X. (fig. 9) he figures a larva about 1,000μ in length, the mouth is wide and occupies the whole of the extreme front end of the head; it is surrounded by long cilia, and the ventral lip is deeply cleft. A tuft of long cilia occurs a little in front of each of the pair of bunches of long provisional setae with which the first segment is armed. The first 19 segments each carry a ventral band of cilia near their posterior margins, and are followed by three atrochal segments, and the anal segment with a very strong band of cilia. No tentacles have yet appeared, and setae are confined to the first segment.

The earliest stage seen by Fewkes was 2000-3000μ in length, and in it all the cilia appear to have atrophied. Very long, slender tentacles, covered with spine-like papillae have appeared by this time, and in addition to the very long setae of the first segment, somewhat shorter ones are present on the remaining segments with the exception of a few at the posterior end which never develop any provisional setae at all. The youngest larva from Port Erin is in this stage; it is probably contracted, and is only 1,500μ in length and 150μ in breadth; the head is rounded in front and bears a pair of tentacles about equal to the body in length, but only 50μ in breadth. Two regions can be recognised in the tentacles: a short proximal part, 100μ long, which stains rather deeply, and a long distal part with very slight affinities for borax-carmine. The latter is a purely larval structure, and is shed after the former has reached a length of 150μ, and has begun to show the characteristic papillate appearance of its anterior surface. These papillae on the permanent part of the tentacle are thick and fleshy, differing markedly from the spine-like processes that are scattered over the purely larval region.

During this time the long provisional setae of the first segment reach a length of 1,000μ, and many of those of the nine succeeding segments are shed and replaced by dorsal and ventral tufts of shorter permanent ones. These ten segments—not eight as in Claparède's larvae (loc. cit.: p. 76; Pl. X., fig. 12), or nine as in the adult form described by McIntosh (1878: pp. 402-3) form a distinct anterior region of the body. A middle region, composed of four (sometimes five) segments, retains the provisional setae for a longer period (see Pl. III., fig. 39), and crotchets instead of capillary setae ultimately replace them; the neuropodial crotchets appear before the notopodial in this region. The remaining segments form a posterior part of the body in which no provisional setae develop. At about the time of the appearance of the neuropodial crotchets of the middle region, both neuropodial and notopodial crotchets appear in the posterior part.

The posterior region is terminated by a conical caudal appendage, situated dorsally, which seems to have been overlooked by Fewkes but is described by Claparède (loc. cit. p. 76; Pl. X., fig. 14). The last "segment" in Fewkes' figs. 10, 11, 13, probably represents this appendage, being devoid of parapodia. None of the Port Erin specimens show the broad terminal "segment" of Fewkes' figs. 12, 12a, perhaps because they are not old enough. The anus opens ventrally on the last segment.

In Fewkes' larvae *three* crotchets "arise from the dorsal region of the parapodium. In addition to these appendages the posterior body segments also bear on a ventral elevation smooth spines similar to those on the anterior and middle regions" (loc. cit. p. 171). In balsam-preparations of the Port Erin larvae I have been unable to find any capillary setae on either the middle or posterior body-regions. Fewkes also found, in the case of the provisional setae, that those of the anterior region (except the first segment) were completely lost at a comparatively early stage, and in this his observations are in agreement with those of Claparède. Specimens from Port Erin, however, show these setae even after the loss of the larval tentacles. This is probably another example of the great variability in the time at which such phenomena occur in Spioniform larvae (see above, pp. 35 and 36), a fact noted by McIntosh in this particular connection (1894: p. 69).

A "Magelona-like" larva has been described from the Cape Verde Islands by Häcker (1898: pp. 20-23; Pl. II., fig. 19). The larval tentacles of this form each bear a prominent swelling about one-third of the way along towards their distal ends, which extend beyond the posterior end of the body when held straight out, and even then are not as long as the setae of the first segment.

CHÆTOPTERIDÆ (Pl. IV., figs. 12-14).

A mesotrochal larva, probably that of *Chaetopterus*, is fairly plentiful in the Port Erin plankton during July. In life it is covered all over with short (10μ) cilia, and bears first one and then two bands of longer (100μ) cilia; the head bears three pairs of small opaque red eye-spots, an anterior pair placed near together on either side of the middle line, and two closely approximated posterior pairs placed one behind the other at the sides of the head. Long rigid cilia occur (singly ?) between the two anterior eyes and in other places upon the head, but their distribution is very hard to determine on account of opacity. The body is terminated at the posterior end by a caudal appendage whose shape and movements show a striking resemblance to the "foot" of a Rotifer; this is almost always completely retracted in fixed specimens.

Trochophore.—The youngest stages found are 400μ by 300μ in size when contracted (Pl. IV., fig. 12). The mouth is very large, and is overhung in front by the broad hood-like head and bounded behind by a deeply cleft under-lip. It leads through a funnel-shaped oesophagus (directed backwards) into the stomach, and thence into a short, broad and very thin-walled rectum; both these last already contain diatoms and other food-material from the exterior.

A single band of strong (100μ) cilia is present encircling the larva in the plane of the pylorus: this "mesotroch" is characteristic of larvae of the Chaetopteridae.

Metatrochophore.—A second band of powerful (100μ) cilia appears a little behind the first, and shortly after this the region between the mouth and the anterior of these bands becomes marked out into segments by the appearance of successive rows of setae, the anterior setae of each row being short and the succeeding ones each a little longer than the one in front (Pl. IV., fig. 13); in the oldest specimen seen too (1,150μ by 900μ in size when contracted), the special stout setae of the fourth chaetigerous segment are visible embedded in the body-wall. Between the second band of powerful cilia and the caudal appendage deeply-staining segments are formed. Whilst segmentation is in progress the deeply-cleft under-lip grows more rapidly than the prostomium (compare Pl. IV., figs. 12 and 13) till in the oldest specimen seen (Pl. IV., fig. 14) the mouth is terminal, and being of enormous size occupies the whole of the anterior end of the body. In this specimen a pair of tentacles have begun to develop on the dorsal surface of the head, a short distance from its anterior margin.

In specimens of these later stages, which were examined alive, the long rigid cilium, situated close to the anterior margin of the prostomium, between the anterior eyes, appeared to be feeling about in front of the animal as it moved along. One of these larvae, also, was seen to take into its mouth a good-sized copepod and swallow it; whilst a Ceratium and a sponge-spicule entered the mouth of another, but were rejected. It was further noticed that the bands of powerful cilia were broken in the mid-ventral line and that a groove, apparently ciliated exactly like the general surface of the body, extended forwards from the anus towards the mouth through the gaps thus left. From Wilson's account of the larvae of *Chaetopterus pergamentaceus* (1882: pp. 285-6) it would appear that this is the case also in the early stage, when only the first of the two bands of powerful cilia is present; but none of these early larvae have been examined alive at Port Erin.

Further stages in the development of these larvae than that shown in Pl. IV., fig. 14, I was unable to follow. Béraneck (1894), however, has described the later stages of another species of *Chaetopterus*. The earliest stage observed by this author corresponds roughly to the latest stage described above, but differs from it in that the segments of the anterior body region (i.e., the part in front of the first mesotroch) are already indicated in the outlines of the body, but as yet bear no setae. Subsequently the region in front of the anterior mesotroch is shown to give rise to the anterior region of the body, the segment between the two mesotrochs to the segment bearing the wing-like lateral processes, and the remainder to the rest of the middle and the whole of the posterior body-regions of the adult.

The development of *Chaetopterus* from the ovum to the Trochophore has been fully worked out for *Chaetopterus variopedatus*, Ren. (*pergamentaceus*, Cuv.) by Wilson (1882). He notes the existence of a temporary mesotroch (anterior to and developed earlier than that retained in the latest trochophore stages), and immediately behind this a pair of lateral flagella, which also disappear during the trochophore stage; these temporary structures appear in the earliest Trochophores (one to five days), which show a ventral mouth of normal size leading through an oesophagus anteriorly to the stomach as in the Trochophores of less modified worms. Apical and anal tufts of long cilia are present, the latter being carried backwards on the end of the caudal appendage as this develops.

Subsequently the mouth is enlarged and pushed forwards so that the now funnel-shaped oesophagus passes backwards instead of forwards, to open into the stomach, which on the third day comes to open to the exterior through a short rectum exactly as in the Port Erin form.

Wilson also describes (loc. cit., pp. 286-8; Pl. XXII., figs. 85-88; Pl. XXIII., fig. 9) a few later stages of a larva provisionally referred by him to the genus *Spiochaetopterus*. The larvae of *Telepsavus* and ? *Phyllochaetopterus* are described by Claparède and Mecznikow (1869: pp. 178-182; Pl. XIV., figs. 1-1E, and 2) and by Fewkes (1885: pp. 177-180; Pl. III., figs. 5-19). The caudal appendage is present in both forms; only one mesotroch is present throughout the development of the former.

III.—TEREBELLIFORMIA.

AMPHICTENIDÆ.

Pectinaria (Pl. IV., figs. 40-47).—Metatrochophore I.—No Trochophore of this worm has been seen, but the youngest Metatrochophore (250μ by 190μ) shows little trace of segmentation and can be only just beyond the trochophore stage. It is ovate in shape, the posterior end being slightly narrower than the anterior. The prostomium is rounded and covered with black pigment spots which tend to be aggregated into a band encircling it just in front of the prototroch, which is slightly raised above the mouth (fig. 40). Segmentation is only indicated by unilateral transverse rows of pigment spots on the posterior part of the larva. The anus is bordered dorsally and laterally by a horseshoe-shaped ridge thickly covered with pigment spots.

A slightly older larva (300μ by 200μ) is shown in Pl. IV., fig. 40; this differs from the previous stage in that there is now a marked enlargement of the body immediately behind the prototroch; the cells in this region appear to contain large vacuoles.

In life the cilia are arranged as shown in Pl. IV., fig. 40, and a pair of opaque reddish-brown eye-spots are present on the head (Pl. IV., fig. 40). The cilia of the prototroch are 75μ long, and are very powerful; at the apex, or slightly dorsal to it, is a tuft of cilia. The mouth is bordered by large lips, which differ from those of the Spioniform larvae in that they are situated entirely behind the prototroch, as in the larvae of *Polynoë*; and from those of the larva of *Polynoë* in that they close in the mouth laterally as well as on the anterior side. These lips are bordered and covered on the inner side with cilia 20μ long; and at the posterior angle of the mouth in the mid-ventral line there is a tuft of 40μ cilia (see Pl. IV., fig. 47c, showing the lips of an older larva, from which these measurements were actually taken). The lips are almost always retracted in preserved specimens, though the larva shown in Pl. IV., fig. 41, has died with them extended, and with the anterior part of the oesophagus protruded beyond them; the tumid posterior wall of the protruded oesophagus in this specimen is much vacuolated; the ridge encircling the organ probably represents the margin of the lips when normally extended. In life the lips are almost invariably held extended to an even greater extent than is shown in Pl. IV., fig. 40,* and give the larva a very characteristic appearance that is well brought out in Willemoes-Suhm's figure of an advanced larva (1871: Pl. XXXI., fig. 11), which, however, he has neither identified nor described. The anus is closely surrounded by extremely delicate short cilia; ventral to the anus is a

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* Subsequent observations suggest that in full extension a trough-shaped structure is protruded beyond the lips, but on account of its extreme sensitiveness I have been unable to examine it very closely.

little spherical projection (Pl. IV., fig. 47; *Sph.*) situated between the arms of the horseshoe-shaped anal ridge (*An. R.*), and immediately in front of this projection is a tuft of 20μ cilia (*T.C. Ntr.*) from which a neurotroch (*Ntr.*) of 8μ cilia extends forwards, to end a little behind the mouth in a short transverse row of 10μ cilia (Pl. IV., fig. 47c; *C. trans.*). The telotroch is situated anterior to the posterior end of the neurotroch. The larva grows considerably both in length and in breadth, and food material from the exterior may be found in the stomach. When the lips are contracted, larvae of the age of that shown in Pl. IV., fig. 41, are about 450μ long by 300μ maximum breadth. The paleae, or large setae that project forwards from the anterior end of the adult, may be seen developing in the dorsal body-wall on each side of these larvae, with their pointed distal extremities close behind the preoral band and their bases several segments further back. The horseshoe-shaped ridge on the posterior surface of the anal segment is considerably enlarged; as before it is covered with pigment spots.

Metatrochophore II.—The setae usually appear at about the period of development of the larva seen in Pl. IV., fig. 41, though one larva with fewer segments than this has setae which have already attained their full length for the larval period (80μ). The body next becomes more elongated; the setae all attain their full (larval) size; and a definite region appears between the last of the chaetigerous segments and the anal segment (Pl. IV., figs. 42 and 43b). This region bears no pigment spots, and shows a very short anterior part, consisting of one segment like those anterior to it, except for the absence of pigment and setae, and a longer (100μ) posterior part—the rudiment of the scapha—which already shows traces of lateral processes in the specimen from which fig. 43 was drawn. The large paleae become more conspicuous; their position relative to the segments is as before, the kite-shaped area which they occupy having diagonal measurements of 300μ by 90μ. They are arranged as shown in Pl. IV., fig. 43a; four lie close together throughout their whole length, and have their distal extremities curled round the point of a short straight fifth spine; the sixth is very hard to distinguish—in fact, it is very doubtful whether it is really present at all yet—and is therefore indicated by dotted lines only. This stage is the one figured by Willemoes-Suhm (see above), and is much more common than the others, whence it may be inferred that it marks a period of quiescence preparatory to metamorphosis.

Metamorphosis.—From the fact that during my 1907 visit to Port Erin I only obtained a single specimen intermediate between the last-mentioned stage, and the secretion of the tube by an almost fully developed worm, it seemed probable that a rapid metamorphosis occurred at this point in the life-history. This single specimen is shown in Pl. IV., fig. 44. The umbrella is much reduced in size, and appears somewhat shrunken; the ciliated band is raised above the mouth on a pair of prominences; the oesophagus appears to be partially everted. The paleae have broken through the dorsal body-wall at about the middle of the first segment, as indicated by the lines of pigment-spots, the larva being now much broader here than in the plane of the prototroch; the presence of the sixth of the paleae is still doubtful. Lateral to the groups of paleae a pair of short tentacles (80μ by 15μ) are now to be seen (Pl. IV., fig. 44; *T. lat.*).

The scapha appears in profile as a region devoid of pigment and segmentation; the cilia of the telotroch are greatly reduced—possibly absent; the anal ridge, however, is still fully developed and covered with black pigment spots. No setae, except the paleae, can be seen in this specimen, but no doubt this is due to their being placed, in the mounted and rather deeply stained specimen, so as to occupy a position above the body, or to their having been shed during fixation; I have therefore inserted them in the figure in the position they occupy in larvae during the quiescent period immediately before metamorphosis.

During my visit to Port Erin in 1908 I had the good fortune to see something of the metamorphosis in progress in a living larva. From a plankton collection taken on August 1, a number of Polychaet larvae were picked out as usual, and placed in fresh sea water in a crystallising dish from which they were taken for examination one by one. Amongst these was an advanced Metatrochophore of *Pectinaria*, which towards the end of the morning presented a slightly abnormal appearance, giving me the impression (when seen under a low power of the microscope) that it would not live much longer, and would even then be of no use for detailed examination; this was not at all surprising, for the larvae usually showed such signs of deterioration after five or six hours, and even sooner. However, the larva was allowed to remain in the crystallising dish, and when I again saw it under the microscope, after an interval of about half an hour, I found that its previous abnormal appearance had been due to the fact that it had been in an early stage of the metamorphosis which it had now almost completed. The metamorphosis was, indeed, so far advanced that I decided to fix the larva at once, and so only gave it a cursory examination with the low power during life. This larva is shown in Pl. IV., fig. 45, from which it will be seen that the paleae now project forwards as in the adult, and that the umbrella is much further reduced than in the earlier metamorphosis stage described above; in fact the creature bears a closer resemblance to the adult than to the larval form. A median tentacle 40μ long has appeared at the anterior extremity of the prostomium—the apical pole of the larva. A little behind this on the ventral surface are a pair of laterally compressed lobes (Pl. IV., fig. 45; *L.*); these are probably developed from the lobes above the mouth over which the prototroch extends in the previous larva; their identification is rendered a little uncertain however by the fact that in the present larva the prototroch, which was only visible during life, seemed to be situated immediately *behind* them. The cilia of the prototroch were no longer active—it is of course possible, though I think not probable, that this was entirely due to the length of time that the larva had been kept in confinement; the creature was quite active otherwise, and twisted backwards and forwards very vigorously.

The lips, usually so conspicuous in the living larva, were not seen at all in this specimen. The black pigment spots of the larva have disappeared completely from the prostomium, and to a considerable extent from the body as well (compare Pl. IV., figs. 42-44 with figs. 45-46). A pair of tentacles is present lateral to the paleae. Uncini are just distinguishable in the body-wall. The creature had not begun to construct its tube when killed.

Tube-secreting stage.—Several little worms in their tubes were taken at the surface, and one of these is shown in Pl. IV., fig. 46. The pair of ventral outgrowths of the head seen in the second of the metamorphosis stages described above are held, in fixed specimens, close against the body (Pl. IV., fig. 46; *L.*), but can be extended out from the body during life.

The extent to which the larval rows of black pigment-spots are retained varies considerably in the different specimens, they being in some confined to a patch on each side of every segment (as in fig. 46), and in others quite as fully developed as in the second metamorphosis stage described above; pigment-spots are now also irregularly scattered over the anterior part of the ventral surface, and a very variable number of larger (20-50μ diameter) patches are present on the dorsal surface of the anterior segments. One pair of eye-spots may be seen in living specimens.

There is no longer any trace of the prototroch, unless it is represented by two short rows of small cilia that are situated one on each side of the head. The short straight capillaries of the larva persist as the dorsal setae of the tubicolous form; ventral uncini are also present. The scapha (Pl. IV., fig. 46; *Sc.*) bears a single median posterior process and a pair of lateral anterior ones; it appears to retain a faint trace of the telotroch in the form of a girdle of faintly-staining cells near its posterior border (Pl. IV., fig. 46; *Ttr.?*); the anal ridge with its pigment-spots has atrophied.

The tube (1,200μ long) is much longer than the worm (800μ long in the fixed condition, the paleae projecting to an additional distance of 150μ); at their widest part both worm and tube are 250μ broad. The walls of the tube are very thin and transparent, and only the most minute particles of foreign matter are attached to it, and these only in very small quantities.

The development of *Pectinaria* has apparently been described by Bobretzky (Verh. Ges. d. Naturf. Kiew; Vol. VIII.; 1873) but I have not been able to refer to his paper. Leschke (1903: p. 127; Pl. VI., fig. 13) also briefly describes this and figures an advanced Metatrochophore with its lips extended. Claparède and

Mecznikow describe and figure a similar larva, but refer it to the Spioniform genus Polydora (1869: p. 175; Pl. XII., fig. 3: see above p. 53). Willemoes-Suhm figures another such larva (1871: Pl. XXXI., fig. 11), but does not identify or describe it.

CONCLUSION.

In the present limited state of our knowledge of Polychaet larvae it would be futile to attempt to give a diagnosis of the larval characteristics of the different families and genera of Polychaets. In the vast majority of genera the early stages are quite unknown, and where anything *is* known of them it is confined to a very small proportion of the known adult species. A table for the identification of the above described species from Port Erin, however, will form a convenient summary of their most useful characters for systematic purposes; and *wherever possible* the particular characters given will be those that at present seem most likely to be of general application.

As I have only been able to describe the trochophore stage in any detail in two of these larvae, and as the latest pelagic stages of the Nereidiformia are characterised chiefly by the characters of the adult, the following table will deal specially with the metatrochophore stage, or in the Spioniformia with this and the nectosoma stage; references to any special characters of the other known stages will be enclosed in brackets.

It should be noted that many of the characteristics mentioned are intimately connected, or even identical with those of the adult worm, and therefore cannot be used as embryological evidence, independent of adult structure, for or against any particular scheme of Polychaet classification.

TABLE FOR THE IDENTIFICATION OF PELAGIC POLYCHAET (METATROCHOPHORE) LARVAE OCCURRING IN PORT ERIN BAY DURING JULY.*

1.	Larva mesotrochal:	**Chaetopteridae.**	
	Larva cylindrical, with four well-developed ciliated bands: †	? **Syllidae.**	
	Larva not as above:		(2)
2.	Long provisional capillary setae present; body usually slender:	(“**Metachaetae,**” Clap.):	(6)
	Prostomium and anal segment bearing numerous black pigment-spots; each intertrochal segment with a girdle of similar spots; body compact; no provisional setae: ‡	**Pectinaria.**	
	Body usually compact; neither provisional setae nor numerous black pigment spots:	(**Nereidiformia**).	(3)
3.	Prototroch replaced by a broad band of cilia: §	**Eunicidae.**	
	True prototroch present:		(4)
4.	Body very compact; setae strongly toothed; rudiments of elytra present; (Trochophore monotrochal and characterised by overhanging upper lip, and presence of simple akrotroch, neurotroch, and *circlet* of apical cilia):	**Polynoidae.**	

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* A few species have been found which are not described above, or included in this table. They are all of rare occurrence, and the table will, I believe, be found sufficient to refer them to their systematic position with as much precision as is possible in the absence of a sufficient description.

† Later stages characterised chiefly, according to Häcker, by a stout sickle-shaped bristle borne by each parapodium.

‡ This form remains pelagic for a short time when tubicolous after a rapid metamorphosis.

§ This character will not serve to distinguish Häcker's later stage of a similar larva in which adult characteristics are appearing.

Two pairs of transparent conical cephalic tentacles present at the anterior end of the prostomium; neurotroch, and **T**-shaped akrotroch with "hook" of cilia present at first; (Trochophore characterised by its great contractility, and by the above form of the akrotroch): **(Phyllodocidae.) (5)**

Parapodia uniramous; rami long except in very early stage; each with compound setae and at least one simple smooth seta (in many Syllids this last distinction would almost certainly not apply): **Syllidae.** (species distinguished by their setae, see Pl. I., figs. 2-4.)

Dorsal and ventral rami of parapodia very short, with smooth and frilled capillary setae; body somewhat elongated: **Nephthydidae.**

5. Three pairs of tentacular cirri; larva rather small: **Phyllodocid A.**

Four pairs of tentacular cirri; larva large: **Phyllodocid B.**

No tentacular cirri; larva large: **Phyllodocid C.**

6. Larva with ventral mouth bordered by large lateral lips enclosing a "vestibule" and causing a ventral break in the continuity of the prototroch; a pair of simple tentacles appear close behind the prototroch in the later stages; (the Trochophore of *Nerine cirratulus* is enclosed in a vitelline membrane characteristic of the species): **(7)**

Larva with anterior broad chaetigerous, middle narrow chaetigerous, and posterior narrow achaetigerous body-regions; a pair of tentacles present, ultimately papillate on the anterior surface, and each in early stages continued into a remarkably long larval tentacle set with spine-like papillae; devoid of cilia; (the earliest stages known, according to Claparède, have a wide anterior gaping mouth, and are polytrochal): **Magelona.**

7. Nototrochs present on all segments, gastrotrochs on segments 5, 7, 10, 13, 15, 17, etc.; much black pigment; (the more advanced larvae show the enlargement and special setae of the 5th segment): **(Polydoridae.)** (8)

Distribution of cilia not as above; or pigment absent: **(Spionidae.)** (9)

8. Ramified stellate patches of intense black pigment present: **Polydora A.**

No such patches present; black pigment arranged in discontinuous transverse bands: **Polydora B.**

9. Larva very small, with three pairs of black eye-spots; provisional setae of 1st segment twice the length of the body: **Spio.**

Larva very small, with one pair of eye-spots which disappear in spirit; provisional setae shorter than the last: **Spionid C.**

Larva very large and transparent; in later stages notopodia and neuropodia of segments 7-11 are decidedly longer than those of the other segments: **Spionid A.**

Larva decidedly smaller than the last and slightly more opaque; segments as long as they are broad; (in the latest pelagic stages branchiae begin to develop at the anterior end): **Spionid B.**

Larva broad and rather short; head produced forwards into a very characteristic " snout " which disappears in fixed specimens; provisional setae very stout and decidedly curved: **Spionid D.**

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EXPLANATION OF PLATES.

Except where otherwise stated, the figures have been drawn in outline with the aid of a camera-lucida from stained specimens mounted in Canada-balsam; and modifications and additions have then been inserted from rough sketches of the living larvae, made in the laboratory at Port Erin.

Reference Letters.

Akr. = Akrotroch.
An. Sty. = Anal style.
Ant. = Anterior mass of deeply staining tissue (brain rudiment).
C. ap. = Apical cilia.
C. or. = Oral cilia.
Cir. i., ii., iii. = Tentacular cirri of segments one, two and three.
E. = Eye.
M. = Mouth.
Ntr. = Neurotroch.
Ph. = Pharynx, or its rudiments.
Post. = Posterior masses of deeply staining tissue (first tissue to show signs of segmentation).
Pr. = Prostomium.
Ptr. = Prototroch.
S. = Setae.
T. = Tentacle.
Ttr. = Telotroch.
i., ii., iii., etc. = Primary segments number one, two, three, etc.

N.B.—It will be noticed that figures 1 to 14 have been distributed, a few at the foot of each of the four plates.

Plate I.

Fig. 1. *Syllid A.*—Metatrochophore, dorsal aspect. × 75. The eye-spots and cilia as seen during life (and as shown here) have only been seen in a more advanced specimen.

Fig. 2. *Syllid A.*—Setae: (*A*) Simple seta; (*B*) Compound seta.

Fig. 3. *Syllid B.*—Setae (*A* and *B*) Simple setae; (*C*) Compound seta.

Fig. 4. *Syllid C.*—Setae. (*A*) Simple seta; (*B*) Compound seta.

Fig. 5. ? *Syllid.*—Optical section. × 75. (From a mounted specimen only.)

Fig. 15. *Polynoë.*—Trochophore seen from the right side. × 75. *C.*, long motionless cilia; *Caec.*, dorsal lobe of stomach. *T. med.*, median tentacle (rudiment).

Fig. 15a. Outline of ventral surface of the same larva as fig. 15 to show more clearly the distribution of the cilia.

Fig. 16. *Polynoë.*—Metatrochophore, dorsal aspect. × 75. *El.*, elytra.

Fig. 17. *Polynoë.*—More advanced Metatrochophore, ventral aspect. × 75. *El.*, elytron. *T. med.*, median tentacle (rudiment).

Fig. 18. *Polynoë.*—Head of Nectochaeta, dorsal aspect. × 75. *T. lat.*, lateral tentacle; *T. med.*, median tentacle.

Fig. 19. *Polynoë.*—Anterior end of one of the most advanced pelagic stages, dorsal aspect. × 75. *El.*, elytron., *J.*, jaws; *P.*, palp; *T. lat.*, lateral tentacle; *T. med.*, median tentacle.

Fig. 20 A and B. Two views of a seta from the ventral tuft of a *Polynoë* larvae.

Fig. 21. *Eunicid* larva. × 75.

Plate II.

Fig. 6. ***Phyllodocid*** *A.*—Trochophore; seen from the right side. × 75. *Akr.*, T-shape akrotroch; *Med. Hk.*, its median "hook" of cilia; *Ntr.*, Neurotroch—expanded laterally to cover a large area in the particular region indicated by the letters.

Fig. 7. ***Phyllodocid*** *A.*—Anterior end of Nectochaeta, dorsal aspect. × 75.

Fig. 7a. ***Phyllodocid*** *A.*—Seta.

Fig. 8. ***Phyllodocid*** *B.*—Metatrochophore, ventral aspect. × 75. (From a mounted specimen only.)

Fig. 9. ***Phyllodocid*** *B.*—Seta.

Fig. 22. *Spionid A.*—Anterior end of one of the most advanced larvae seen, dorsal aspect. × 60. (From a mounted specimen only.)

Fig. 23. *Spionid A.*—First parapodium of the left side of the above larva. × 80 (diagrammatic; the full length of the long notopodial provisional setae is not shown).

Fig. 24. *Spionid A.*—Second to third parapodium of the left side of the above larva. × 80 (diagrammatic).

Fig. 25. *Spionid A.*—Left parapodium of one of the 4th-6th segments of the above larva. × 80 (diagrammatic*).

Fig. 26. *Spionid A.*—Left parapodium of one of the 7th-11th segments of the above larva. × 80 (diagrammatic*).

Fig. 27. *Spionid A.*—Parapodium from a larva in the stage before the differentiation of the parapodia of segments 7-11.

Fig. 28. *Polydora A.*—Nectosoma, dorsal aspect. × 75; stage at which the tentacles first become visible—in the figure they are obscured by the prototroch. The seta and the cilia have been omitted in part in order that the pigmentation may be more clearly seen.

Fig. 29. *Polydora A.*—Anterior end of a more advanced Nectosoma, dorsal aspect. × 75. (From a mounted specimen only.)

Fig. 30. *Polydora A.*—Setae. (*A*) Left side of the specially modified 5th segment with its setae; dorsal aspect; (*B*) Crotchet (hooded ?); more highly magnified than (*A*).

Fig. 31. ? *Polydora.*—Seta.

Fig. 32. *Polydora B.*—A segment from about half way along the body, to show the arrangement of the pigment; setae and cilia not shown.

* The spherical projection between the rami is not present on all of these parapodia, and its outline has, therefore, been indicated in figs. 25 and 26 by a dotted line.

PLATE III.

Fig. 10. *Nephthys.*—Metatrochophore, ventral aspect. × 75. (From a mounted specimen only.)

Fig. 11. *Nephthys.*—Setae. (*A*) Frilled seta; (*B*) Smooth seta.

Fig. 33. *Spionid B.*—Nectosoma, anterior end, dorsal aspect. × 75. (From a mounted specimen only). *S. per.*, permanent setae; *S. prov.*, provisional setae.

Fig. 34. Posterior end of the same larva, ventral aspect. × 75.

Fig. 35. *Spionid C.*—Metatrochophore. (From a preserved specimen except for the eyes.) × 75.

Fig. 36. *Spionid D.*—Metatrochophore, fully contracted. × 75. (From a mounted specimen only).

Fig. 37. *Spionid D.* Anterior end of more advanced and well expanded Metatrochophore. × 75. Only the bases of the setae shown. *Pr.*, snout-like anterior prolongation of the prostomium.

Fig. 38. *Spio.*—Metatrochophore. × 75. (From a mounted specimen only.)

Fig. 39. *Magelona.*—Nectosoma which has shed the provisional setae from all segments of the anterior body-region except the first; the larval region of the tentacle of the left side has also been shed; × 75. *S. per. cap.*, permanent capillary setae of the anterior body-region; *S. per. cr.*, crotchets (permanent setae) of the middle and posterior body-regions; *S. prov.*, provisional setae of the first segment and of the middle body-region; *T. larv.*, larval portion of the right tentacle; *T. per.*, permanent portion of the tentacles.

Figs. A. and B. Diagrams of akrotroch of *Phyllodocid C.*—(A) Profile; (B) Surface view. *l.*, lateral extensions; *m.*, median piece; *m. l. c.*, median long cilia; *p. hk.*, paired "hook" of long cilia.

Fig. C. Trochophore of *Nerine cirratulus.* (After Leschke, modified from Cunningham and Ramage).

Plate IV.

Fig. 12. *Chaetopterus*.—Trochophore. Optical section. × 40. (From a mounted specimen only.) *R.*, rectum; *St.*, stomach.

Fig. 13. *Chaetopterus*.—Metatrochophore, ventral aspect. × 40. Fully contracted. *E. ant.*, anterior pair of eyes, immediately in front of which a long rigid cilium is seen; *E. post.*, right eyes of the two closely approximated posterior pairs. *Mtr.* 1 *and* 2. anterior and posterior mesotrochs.

Fig. 14. *Chaetopterus*.—More advanced Metatrochophore than that of fig. 13; dorsal aspect. × 40. (From a mounted specimen only.) *Cd.*, caudal appendage; *S. sp.*, special setae of the fourth segment; *U.-L.*, under-lip.

Fig. 40. *Pectinaria*.—Very early Metatrochophore, from the right side. × 75. *An. R.*, anal ridge.

Fig. 41. *Pectinaria*.—More advanced Metatrochophore with oesophagus protruded; from the left side. × 75. (From a mounted specimen only.) *An. R.*, anal ridge; *Oe.*, protruded oesophagus; *Pal.*, developing paleae seen through the body-wall.

Fig. 42. *Pectinaria*.—Metatrochophore almost ready for metamorphosis; ventral aspect. × 75. (From a mounted specimen.) *An. R.*, anal ridge. The prototroch is indicated at the sides; its further course is marked by the absence of pigment except in the region of the mouth, where it could not be followed precisely.

Fig. 43. *Pectinaria*.—Parts of the most advanced Metatrochophore seen. (*A*) Paleae as seen through the body-wall. × 120; (*B*) Posterior end, ventral aspect. × 75. To show the rudiment of the scapha (*Sc.*).

Fig. 44. *Pectinaria*.—Early metamorphosis stage from the left side. × 75. (From a mounted specimen only). *Pal.*, paleae beginning to project from the body-wall; *T. lat.*, lateral tentacles.

Fig. 45. *Pectinaria.*—Later metamorphosis stage; from the left side. × 75. (From a mounted specimen.) *L.*, compressed lobes of the ventral surface; *Pal.*, paleae; *Ptr.*, probable position of the prototroch (visible during life only, and therefore indicated by a dotted line); *Sc.*, scapha; *T. lat.*, lateral tentacle; *T. med.*, median tentacle.

Fig. 46. *Pectinaria.* Tubicolous stage before the commencement of life on the sea-bottom; ventral aspect. × 75. (From a preserved specimen only.) *L.*, compressed lobes of the ventral surface; *Pal.*, paleae; *Sc.*, scapha; *T. lat.* 1 *and* 2, right lateral tentacles (of outer and inner pair respectively); *T. med.*, median tentacle; *Tb.*, tube secreted by the worm; *Ttr* ?, remnant of telotroch ?

Fig. 47. *Pectinaria.*—Parts of the Metatrochophore as seen during life, to show the arrangement of the cilia. (*A*) Anal segment from behind; (*B*) Posterior end from the right side; (*C*) Oral region from the right side; *An.*, anus; *An. R.*, anal ridge; *C. an.*, delicate cilia round the anus; *C. trans.*, transverse row of cilia at the anterior end of the neurotroch; *C. or.*, oral cilia; *Ntr.*, neurotroch; *Ptr.*, prototroch; *Sph.*, spherical prominence immediately behind the posterior end of the neurotroch; *T. C. Ntr.*, tuft of cilia in which the neurotroch terminates; *T. C. or.*, tuft of cilia which marks the posterior boundary of the oral ciliated region; *Ttr.*, telotroch.

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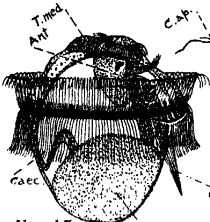


FIG. 15.

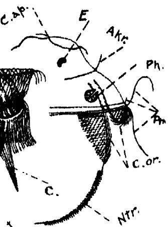
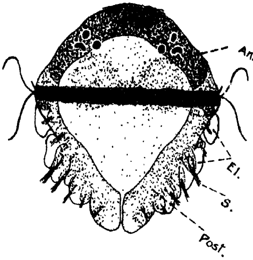


FIG. 15a.

FIG. 16.



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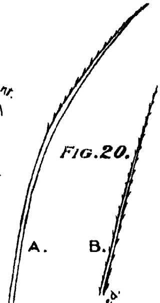

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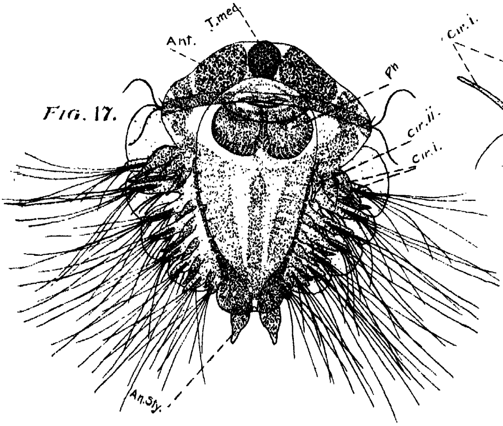


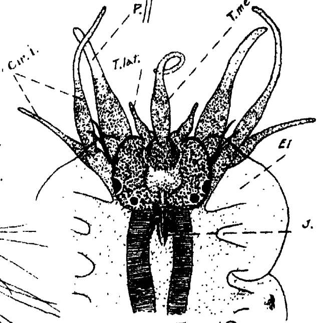
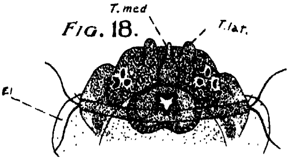


FIG. 19.

FIG. 18.



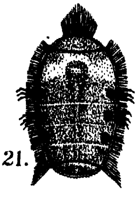


FIG. 21.

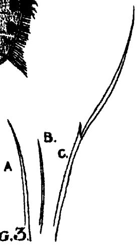


FIG. 3.

FIG. 4

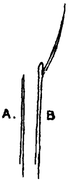
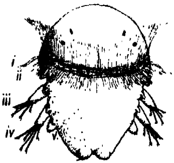


FIG. 1.



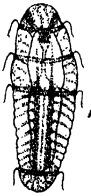


FIG. 5.

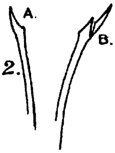


FIG. 2.

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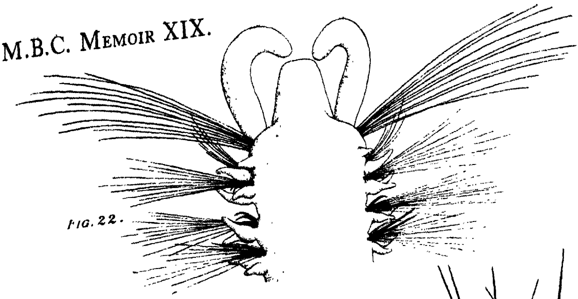

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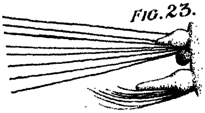

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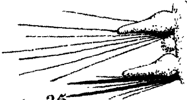

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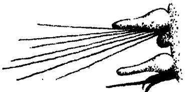

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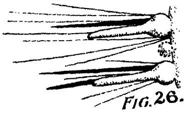

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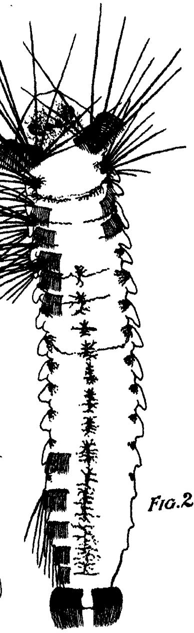

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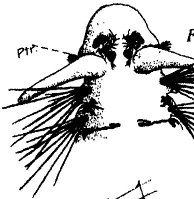

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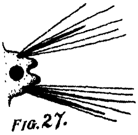

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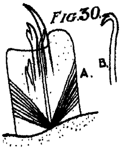

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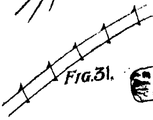

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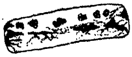

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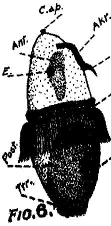

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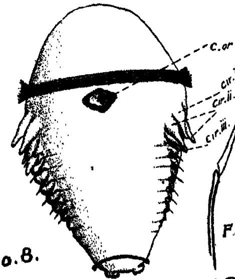

C.or.
Cir. i.
Cir. ii.
Cir. iii.

Fig. 8.

Fig. 9.

Fig. 7a.

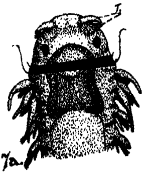

Fig. 7.

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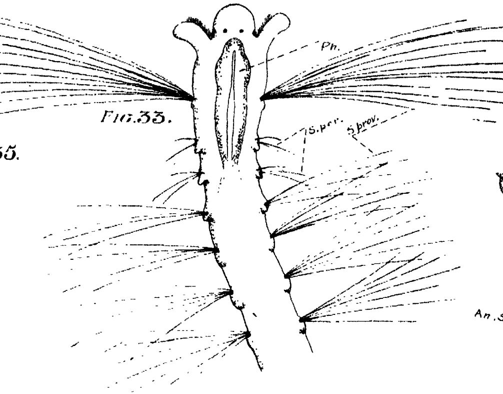
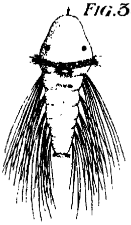


FIG. 33.

FIG. 35.



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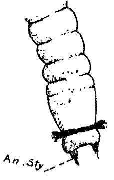


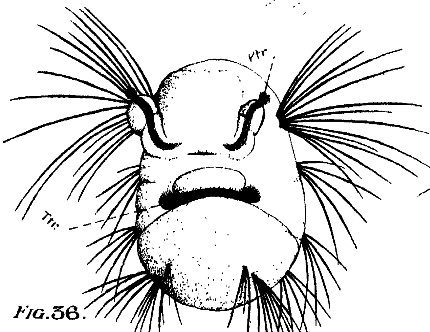
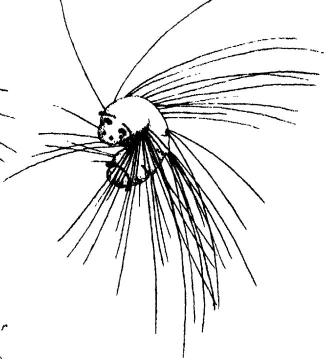


FIG. 36.

FIG. 38.



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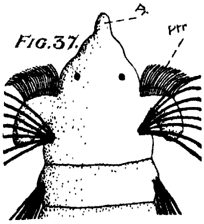

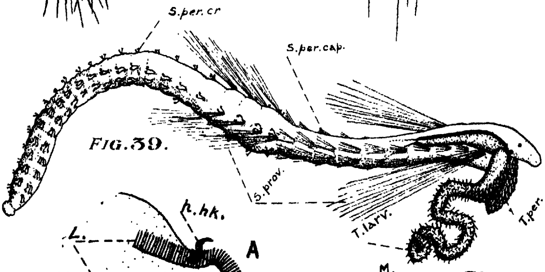

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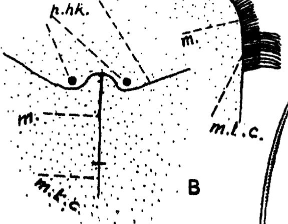

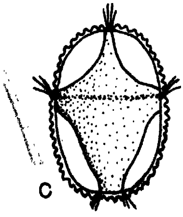

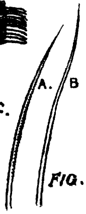

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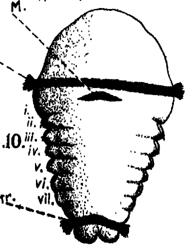

FIG. 10.

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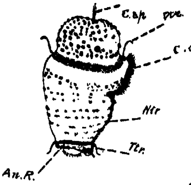
FIG. 40.



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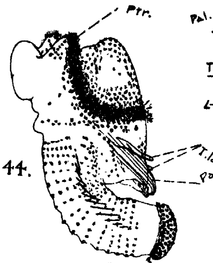

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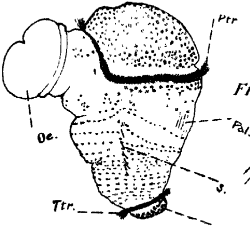

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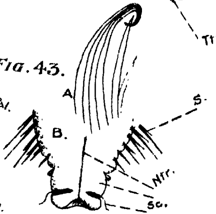

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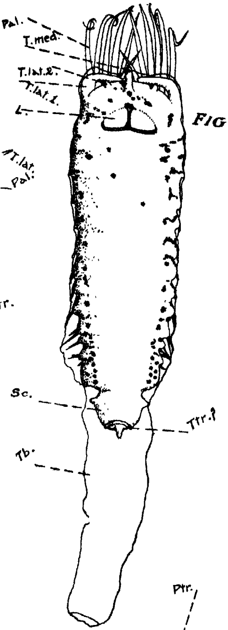

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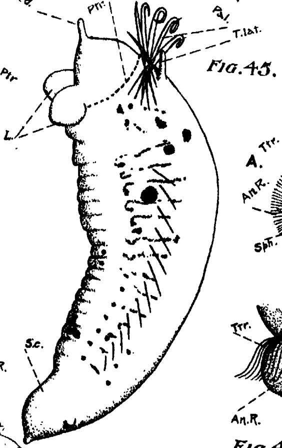

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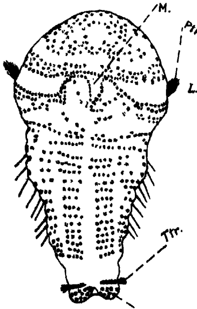

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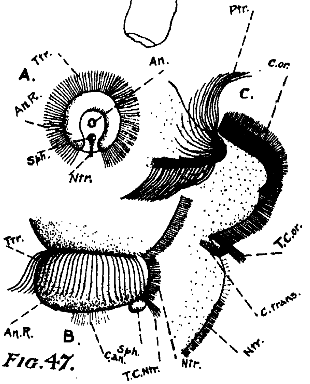

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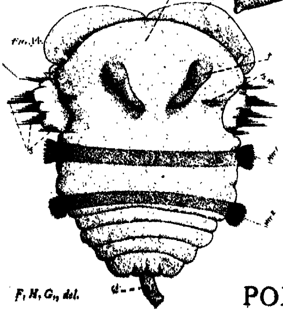
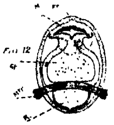


Fig. 12



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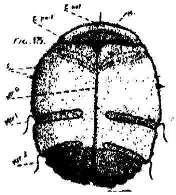

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